ECONOMIC AND ENGINEERING DEVELOPMENT OF BURMA

KNAPPEN - TIPPETTS - ABBETT - McCARTHY
ENGINEERS
(KNAPPEN TIPPETTS ABBETT ENGINEERING CO.)
62 WEST 47TH STREET
NEW YORK 36, N.Y.
PLAZA 7-8001

ERNEST F. TIPPETTS
ROBERT W. ABBETT
GERALD T. McCARTHY
WILLIAM Z. LIDICKER
JAMES H. STRATTON

PLEASE REPLY TO
SOUTH EAST ASIA OFFICE
P.O. BOX 1484
PROME COURT
RANGOON, BURMA
SOUTH 556 & 572
CABLE ADDRESS:
"KNAPENG RANGOON"

August 7th, 1953

THE HONORABLE U WIN,
Minister for National Planning and Religious Affairs,
Prome Court, Prome Road,
RANGOON, BURMA.

DEAR SIR,

The Consultants take pleasure in transmitting to you the accompanying "Comprehensive Report on the Economic and Engineering Development of Burma."

It is the earnest hope of all who have contributed to the preparation of the Report that it will be a trustworthy guide to social and industrial progress that will endure and strengthen through the years to come.

The Consultants desire to express their thanks and appreciation for the honor and opportunity afforded them to participate in the bold, creative, and historical measures being set in motion by the Union of Burma to secure for her people the full enjoyment of their rich resources.

Respectfully yours,

Homer B. Pettit

General Manager

COMPREHENSIVE REPORT

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ECONOMIC AND ENGINEERING DEVELOPMENT OF BURMA

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PREPARED FOR THE
GOVERNMENT OF THE UNION OF BURMA

VOLUME I

•

INTRODUCTION
ECONOMICS AND ADMINISTRATION
AGRICULTURE AND IRRIGATION
TRANSPORTATION

•

AUGUST 1953

KNAPPEN TIPPETTS ABBETT McCARTHY
ENGINEERS

IN ASSOCIATION WITH
PIERCE MANAGEMENT, INC.
AND
ROBERT R. NATHAN ASSOCIATES, INC.

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FOREWORD

AUTHORITY

This Comprehensive Report is being submitted to the Government of the Union of Burma as the concluding service in the fulfillment of the contract dated August 8, 1951, and terminating on August 8, 1953, between the Government of the Union of Burma and Knappen Tippetts Abbett Engineering Company of New York City. As provided in the contract, the Knappen Tippetts Abbett Engineering Company has associated itself with Pierce Management, Inc., of Scranton, Pennsylvania, Coal and Metal Mining Engineers, and Robert R. Nathan Associates, Inc., Washington, D.C., Economists. The dollar costs under this contract are being paid by the Technical Cooperation Administration of the United States.

Article I, Section C, subsection 1c of the contract provides that "at the conclusion of the term of this contract, the Consulting Engineer will present a written report recommending a comprehensive, integrated program for the over-all development of the resources of Burma and governmental and private measures in addition to those which may already have been taken, designed to place such program into operation . . ." The recommendations shall be made "in the light of the desire of the Government to improve the productivity, production, and standard of living of the people of Burma as rapidly as possible and to achieve a diversified and balanced economy appropriate to the national and economic independence of Burma." This Report is now presented in fulfillment of that requirement.

SCOPE

The responsibilities of Knappen Tippetts Abbett Engineering Company and its associates under the contract fall into six categories:

1. Surveys and Reports
    - *a.* Preliminary Survey and Report.
    - *b.* Project Surveys and Reports.
    - *c.* Comprehensive Report.
2. Preparation of Applications for Financing.
3. Services Relative to Specific Projects.
4. Continuous Engineering, Consulting, and Economic Advisory Services.
5. Purchasing Services.
6. Training of Burmese technicians.

Under category 1*a*, Knappen Tippetts Abbett Engineering Company, following a preliminary survey of the resources and the national economy of Burma, submitted a written Preliminary Report on January 31, 1952. Subsequently, a large number of detailed reports on specific projects have been submitted. Many services have been rendered relative to specific projects; continuous engineering consulting, and economic advisory services have been rendered and on occasion purchasing services have been performed. A number of Burmese technicians have assisted in the work, and have received training in various engineering and economic fields and in office procedures. No preparation of applications for financing has been requested.

In the foreword to the Preliminary Report it was observed that "because of the shortage of time and insufficient primary information, it has not been possible to achieve the degree of precision or balance in the proposed program which it is hoped will characterize the Final Report . . . Likewise these limitations have prevented the establishment of a final order of priorities for projects and final judgements concerning policies." This Comprehensive Report recommends a balanced program of public and private investment for the entire economy, together with measures to train the necessary skilled, professional, technical and managerial workers, indicates the feasibility of the program, recommends priorities and indicates the measures necessary to carry it out.

ORGANIZATION

The following principals have visited Burma to initiate and supervise the survey, furnish consulting and advisory services during its course and assist in the preparation of the Preliminary and Comprehensive Reports:

Ernest F. Tippetts, Partner, Knappen Tippetts Abbett Engineering Company.
Robert W. Abbett, Partner, Knappen Tippetts Abbett Engineering Company.
Gerald T. McCarthy, Partner, Knappen Tippetts Abbett Engineering Company.
James H. Pierce, Chairman, Pierce Management, Inc.
John S. Marshall, President, Pierce Management, Inc.
Robert R. Nathan, President, Robert R. Nathan Associates, Inc.

The General Manager of the survey is Homer B. Pettit, and the Deputy General Manager and Chief Engineer is John B. Alexander.

The following have served in Burma as Consultants:

Economic Geologist: Stuart St. Clair.
Economist: Louis J. Walinsky.
Editorial: Donald P. Barnes.
Hydroelectric Engineer: Frank P. Fifer.
Industrial Engineers: Donald F. Othmer, Lawrence E. Peterson.
Mining Engineer: Evan Bennett.
Transportation Engineer, Ports and Waterways: Francis B. Wilby.
Transportation Engineer, Railways, Highways, Airways, and Communications: Ewart G. Plank.

The following have been members of the field staff:

Frank D. Ahern, Construction Engineer.
Carleton W. Bacon, Communications Engineer.
Thomas H. Baker, Highway Engineer.
B. A. Blanchard, Management Administrator.
Charles MacA. Carman, Industrial Engineer.
J. B. Chadwell, Office Manager.
Donald E. Cupp, Industrial Engineer.
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Irving H. Licht, National Income Economist.
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Ernest J. Petersen, Chief Draftsman.
Arthur R. Reitter, Irrigation Engineer.
Benjamin P. Robinson, General Civil Engineer.
Alfred A. Strauss, Industrial Engineer.
Shigeharu Takahashi, Agricultural Economist.
William W. Tamplin, Economic Geologist.
George M. Tapley, Hydroelectric Engineer.
Eugene P. Tubman, Construction Engineer.
Peter N. Vukasin, Economic Analyst.
Paul A. White, Industrial Engineer.
Donald Wilhelm, Jr., Industrial Economist.
Kenneth B. Wolfskill, Highway Engineer.
George O. Zalkind, Ports and Waterways Engineer.

The following members of the home office staffs have devoted a large part of their time to the survey during the period of the contract:

Volney A. Poulson, Project Engineer.
A. J. Creshkoff, Project Economist.

ACKNOWLEDGEMENTS

Heartfelt appreciation is expressed to the Hon. U Nu, Prime Minister of the Government of the Union of Burma, whose effective consecration to promoting the welfare of Burma has been an inspiration to the survey group and whose steady support of the aims of the survey has facilitated the work throughout the contract period. Gratitude is expressed also to all of the Ministers of the Government, whose unfailing courtesy and cooperation has opened the resources of their agencies to the survey staff members and greatly increased the effectiveness of their work.

All of the Ministries and other agencies of the Government of the Union of Burma from whom information and other help has been sought have been extremely cooperative, as have the personnel of the Special Technical and Economic Mission of the United States Technical Cooperation Administration in Rangoon, the personnel of the various missions of the United Nations and its affiliated organizations, and a large number of other individuals and firms. Because of the many sources from which aid has been received, the absence from Burma as this Report is being prepared of some persons who earlier served as members of the field staff, and human error, it has been necessary to omit from acknowledgement the names of some from whom important aid was received. To all of these as well as to the individuals hereinafter listed are extended the deepest appreciation of the associated firms and their staffs.

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Lt.-Col. Ba Han, Officer on Special Duty.

Central Statistical and Economics Department

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U Thet Tun, Assistant Director (Economics).
U Nyunt We, Assistant Director (Economics).
Daw San Shin, Assistant Director (Statistics).
And the entire staff of the department.

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A. D. Patraval, Ibcon Consultant.

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U Kyaw Win, Divisional Engineer, Wireless.
H. N. Laval, Personal Assistant, Traffic.
U Myoe Thaw, Personal Assistant, Engineer.
U Soe Thin, Assistant Engineer, Electrical.
U Myint Aung, Assistant Engineer, Marine Station.
U Tha Hla, Assistant Engineer, Transmitting Station.
D. S. McMahon, Assistant Engineer, Receiving Station.
U Sein Ban, Superintendent, Telecommunications Stores.
H. Mainuddin, Superintendent, Central Telegraph Office.
A Aung Tah, Sub-Divisional Officer, Prome.
U Yoe Maung, Sub-Divisional Officer, Rangoon.
U Tun Zan, Attached Officer, Wireless.
U Nyint We, Assistant Superintendent, Instrument Room.
U Kyaw Wan, Office Superintendent.

Union of Burma Airways

U San Thein, Chairman.
U Taw, General Manager.
O. W. Ah Hee, Chief Accountant.

Department of Civil Aviation

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U Kyaw Tun, Assistant Director.

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H. Keeley, Former Commissioner, Arakan Division.
W. J. Carrott, Commissioner, Sagaing Division.
U Mo Myint, Commissioner, Tenasserim Division.
U Kyaw Zan, Deputy Commissioner, Akyab.
U Thaung Lwin, Deputy Commissioner, Moulmein.
U Maung Maung, Deputy Commissioner, Pegu.
U Thaung, Deputy Commissioner, Tharrawaddy, Warden of the Oilfields.
Dr. Tun Aung, Civil Surgeon, Moulmein.

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Technical Assistance Administration

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International Labor Office

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OTHER ASSOCIATIONS

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U Ba Yin, Chairman, Board of Rice Surveyors.

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Burma Corporation

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U Pa, Head Accountant, Liberty Tobacco Company.
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U Ba Toke, Office Manager, Maha Bandoola Dyeing and Printing Works.
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Individuals—*contd.*

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Mr. Ong Htyan Hoke, Proprietor, National Rubber Works.
Mr. Ong Htgin Shu, Manager, National Rubber Works.
Mr. Samuel Young, Manager Rubber Estate.
U Sway Tin, Partner, U Po Nyein and Co.

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Syncro Machinery Co., Perth Amboy, New Jersey.
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U. B. Machinery Co., New York City.
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PART I

INTRODUCTION

CHAPTER I

RESOURCES FOR BURMA'S DEVELOPMENT

A. INTRODUCTION

A full inventory and understanding of Burma's available natural and human resources is an essential prerequisite to a plan of development which will yield maximum results in minimum time. Burma is richly endowed with natural resources. She is less fortunate with respect to the availability of modern machines and equipment. Although the level of human abilities is generally high, there is a scarcity of technically trained and experienced personnel. This chapter presents a summary description of these resources.

B. PHYSICAL GEOGRAPHY

1. LOCATION AND TOPOGRAPHY

The Union of Burma lies between 93° and 103° East longitude and 28° and 10° North latitude. Its boundaries encompass an area of 262,000 square miles. It has nearly double the land area of Japan, is somewhat larger than France, and approximately equal in size to the State of Texas.

Roughly, Burma's boundaries form a diamond 500 miles across from east to west and 800 miles long from north to south with the long, narrow coastal strip known as Tenasserim extending from the south-eastern side of the diamond some 500 miles farther south into the Malayan Peninsula.

Pakistan and India lie along the northwest side of the diamond, China along the northeast side, and Indo-China and Thailand along the southeast; the Tenasserim extends far down along the western boundary of Thailand. The Bay of Bengal and the Andaman Sea form the southwestern and southern boundaries. The length of the coastline from Pakistan in the northwest to Thailand in the southeast is about 1,200 miles.

Burma's historical isolation from her neighbors is closely associated with geographical features. The Indian subcontinent on the west and the Malayan peninsula on the east both extend to the south of Burma, and the sea routes from the one to the other have by-passed Burma. On land, mountain barriers formed by the fingers of the Tibetan mountains cut Burma off from neighboring countries. On the north-western side, the northern extension of the Arakan Yomas (hills) and the Naga, the Chin, and the Lushi Hills form the boundaries. The northeastern boundary lies in the Kachin and Shan Hills, and on the southeast the Shan and Tenasserim Hills are barriers to communication and trade.

These and related hills are oriented in north-south ranges and overlie much of the larger part of the country's area. The Arakan Yomas in the southwest isolate the Arakan coast from the rest of the country. The highland plateau of the Shan Hills covers all of east central Burma. Even the central plain of southern Burma is divided into two parts by the semi-isolated Pegu Yomas. The rest of Burma consists of the valleys and deltas of the Irrawaddy, Sittang, and Salween rivers and of the Arakan and Tenasserim coastal strips. It is these lowland areas that contain and support the bulk of the population and that are economically the most significant.

The three main river systems, the Chindwin-Irrawaddy, the Sittang, and the Salween, flow in a general southerly direction. The Irrawaddy River has its source in extreme northeast Burma. Its southern and sometimes southwesterly course traverses the length of the country. Its valley forms the cultural, historical, and economic heartland of Burma. As it emerges from the main southern valley of Burma between the Arakan and Pegu Yomas and approaches the sea, the Irrawaddy branches into creeks and rivulets to form the Delta, one of the great rice granaries of the world, with an area of some 10,000 square miles.

The Chindwin River rises far to the northwest in the Naga Hills, and joins the Irrawaddy from the west in central Burma at the town of Myingyan. The water-shed of the Irrawaddy-Chindwin system constitutes about 55% of the area of Burma.

The Sittang rises in central Burma and drains the area east of the Pegu Yomas. At the coastal plain it opens out into a wide estuary noted for its tidal bores, and empties its waters into the Gulf of Martaban between Rangoon and Moulmein. The fact that a large part of its 350-mile course is difficult to navigate limits its commercial significance.

Still farther east is the third main river of Burma, the Salween. It has its source in Tibet and enters the sea near Moulmein. It is a swift river that flows along a deep winding gorge. Rapids and cascades confine its use mostly to small craft operating within restricted areas and to the floating of teak logs.

Three minor river systems are important. The Rangoon River provides Rangoon's gateway to the sea, and its tributaries link Rangoon to the Irrawaddy system. The Kaladan–Lemro river system forms a network in the fertile western coastal plain of Burma, west of the Arakan Yomas, centering on the seaport of Akyab. The Great Tenasserim River, although it flows throughout a considerable length of the Tenasserim littoral, is navigable for only short distances above its mouth at Mergui.

2. CLIMATE

Two thirds of the country is in the tropical and one third in the temperate zone. The main determinants of the country's climate other than location are the monsoon and the configuration of the land. Variations in the land surface from the sea coast to the mountains bordering Tibet and the southern offshoots of these mountains cause different climatic conditions in various sections of the country.

The seasons in Burma are:

The monsoon (wet weather)	Mid-May to Mid-October
The post-monsoon (humid weather)	Mid-October to Mid-November
The cold weather	Mid-November to April
The pre-monsoon (hot weather)	April to Mid-May

The monsoon winds which blow toward Burma, across the Bay of Bengal from a southwesterly direction, carry a considerable amount of humidity, resulting in the wet weather from mid-May to mid-October. When they meet the Arakan and Tenasserim Yomas, these winds lose most of their moisture, and somewhat more than 200 inches of rain fall per year in the Arakan and Tenasserim coastal regions. This factor produces the Dry Zone in Central Burma, roughly indicated by areas 1 and 2 on the map, "Natural and Artificial Vegetation of Burma" (Plate 1). Here the rainfall averages 25 to 50 inches per year, and its extreme irregularity causes frequent crop failures. In the delta plains of the Irrawaddy and Sittang, annual rainfall is as regular as in the coastal strips along the Yomas, but is lower. It averages a little more than 100 inches per year in the main delta region, and somewhat less in the northern delta. The southwest monsoon current, unable to climb the Shan Hills, changes its direction to southeast, following the river valleys and giving up little moisture in Central Burma.

After leaving the central plain, the winds lose more moisture, causing somewhat greater rainfall on the Shan Plateau, and another heavy precipitation zone in the hills and narrow valleys of Northern Burma.

About the beginning of November the monsoon moves from southwest to northwest. This is the movement of the lower air currents of the southwest monsoon from central Burma to southern Burma followed by dry northwesterly land winds. The period continues until the southwest monsoon returns with its moisture from the ocean.

The temperatures in the Shan Plateau, the Arakan Yomas, and the northern hills are the lowest, remaining between 70° and 80° in the summer. Over most of these tracts, frosts are common in December and January. The Dry Zone, at the other extreme, has an annual average temperature of about 90°. Temperatures in the coastal plains and deltas fall between these extremes with less seasonal fluctuation than in the other two areas because of the influence of the sea. Table I–1 gives selected temperature data from official records.

TABLE I – 1

AVERAGE ANNUAL MAXIMUM AND MINIMUM TEMPERATURES FOR SELECTED TOWNS

	Average Annual	
	Maximum (°*F.*)	*Minimum* (°*F.*)
Myitkyina (Northern Burma)	92	50
Maymyo (Shan States)	84	39
Mandalay (Dry Zone)	102	59
Akyab (Arakan Coast)	92	59
Tavoy (Tenasserim Coast)	97	53
Rangoon (Delta)	98	64
Bassein (Delta)	86	73

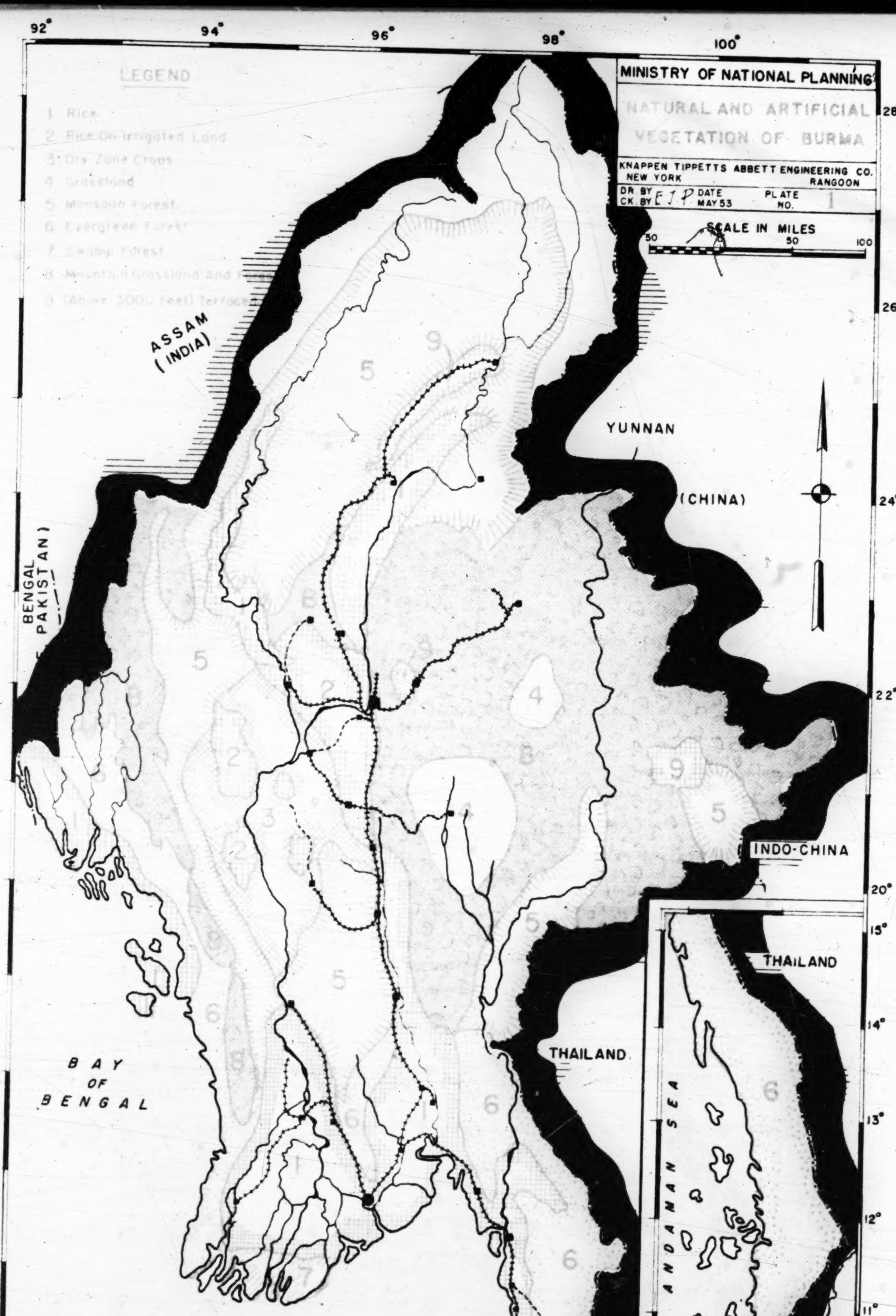
3. SOILS AND VEGETATION

Most of the information available on soils comes from District Settlement Reports and is nontechnical. The deltaic soils are principally heavy clays or clay loams overlying slaty blue clay. They have sufficient potash and are generally deficient in nitrogen and phosphates. Dry Zone soils are generally of a lighter texture. More detailed soil information is given in Chapter VIII, Agriculture.

Along the river banks soils are generally silt deposits which are covered in many places with a layer of sand. Exposed banks and islands are cropped during the dry season. Some of these lands whose fertility is replenished occasionally by silt deposition are usually rich and yield good crops.

The map, "Natural and Artificial Vegetation of Burma" (Plate 1), indicates the natural and artificial vegetation of Burma. The coastal areas having more than 80 or 90 inches of rainfall a year were originally forested with hardwood, but most of the accessible portions have been cleared for paddy. The hills remain forested.

In the delta, near the sea, mangroves thrive in swamps along the coast and tidal creeks. On the



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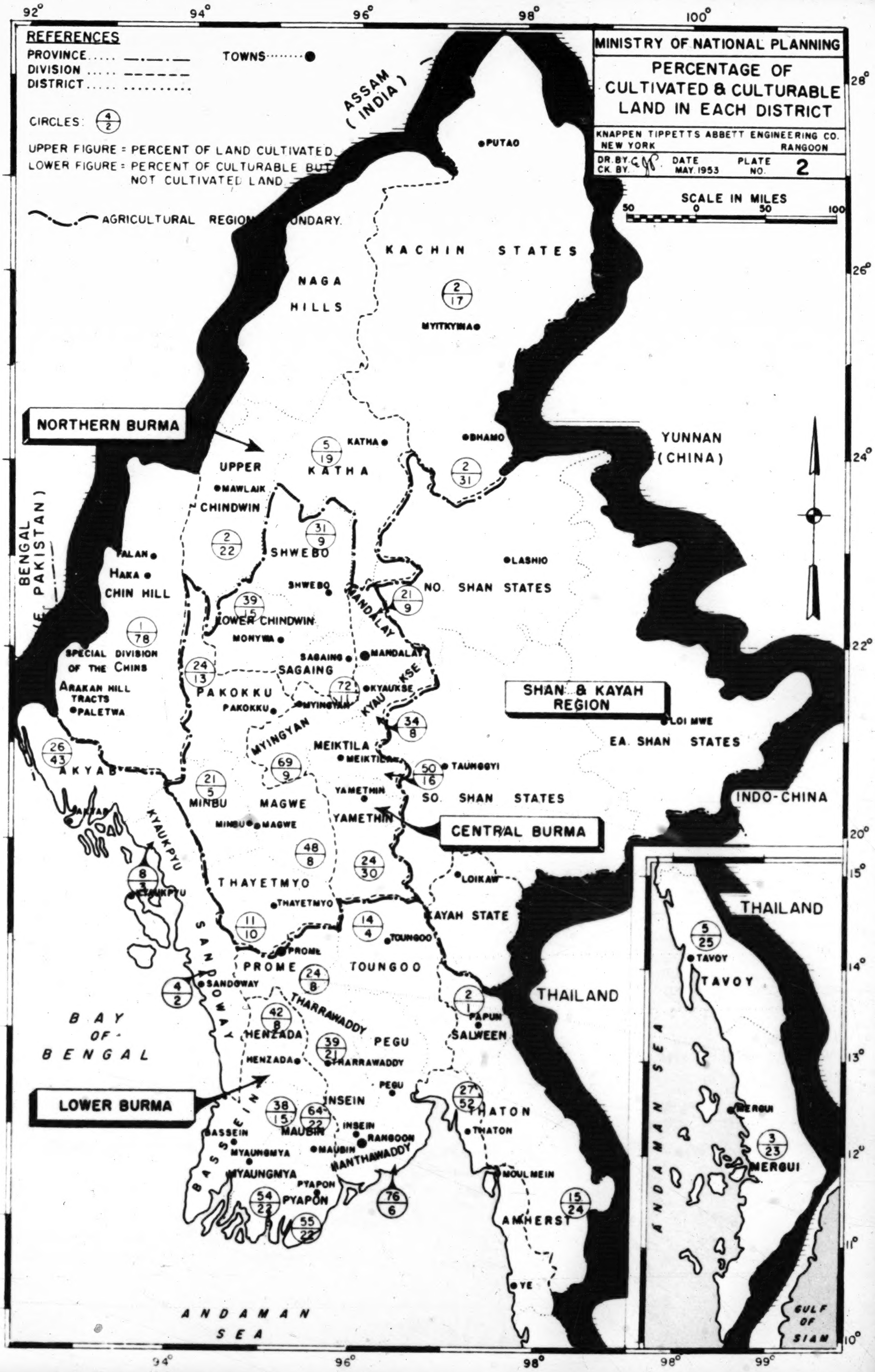
NATURAL AND ARTIFICIAL VEGETATION OF BURMA

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY
CK. BY E.J.P. DATE MAY 53 PLATE NO. 1

Sources:- A Geography Of Burma By F. G. French And L. Dudley Stamp

LEGEND
1 Rice
2 Rice On Irrigated Land
3 Dry Zone Crops
4 Grassland
5 Monsoon Forest
6 Evergreen Forest
7 Swamp Forest
8 Mountain Grassland And Forest
9 (Above 3000 Feet) Terraces
SCALE IN MILES
50
50
100
92°
94°
96°
98°
100°
28°
26°
24°
22°
20°
ASSAM (INDIA)
BENGAL PAKISTAN
YUNNAN
(CHINA)
INDO-CHINA
THAILAND
BAY OF BENGAL
ANDAMAN SEA
THAILAND
ANDAMAN SEA
GULF OF SIAM
15°
14°
13°
12°
11°
10°
98°
99°
1
2
3
4
5
6
7
8
9



MINISTRY OF NATIONAL PLANNING

PERCENTAGE OF CULTIVATED & CULTURABLE LAND IN EACH DISTRICT

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON
DR. BY C.J.P. DATE MAY 1953 PLATE NO. 2
CK. BY

REFERENCES
PROVINCE
DIVISION
DISTRICT
TOWNS
CIRCLES: 4/2
UPPER FIGURE = PERCENT OF LAND CULTIVATED
LOWER FIGURE = PERCENT OF CULTURABLE BUT NOT CULTIVATED LAND
AGRICULTURAL REGION BOUNDARY
SCALE IN MILES
50
0
50
100
92°
94°
96°
98°
100°
28°
26°
24°
22°
20°
ASSAM (INDIA)
BENGAL (PAKISTAN)
YUNNAN (CHINA)
INDO-CHINA
THAILAND
BAY OF BENGAL
ANDAMAN SEA
NORTHERN BURMA
CENTRAL BURMA
LOWER BURMA
SHAN & KAYAH REGION
KACHIN STATES
2/17
PUTAO
MYITKYINA
NAGA HILLS
BHAMO
2/31
KATHA
5/19
UPPER CHINDWIN
MAWLAIK
2/22
SHWEBO
31/9
LOWER CHINDWIN
39/15
MONYWA
FALAM
HAKA
CHIN HILL
1/78
SPECIAL DIVISION OF THE CHINS
ARAKAN HILL TRACTS
PALETWA
AKYAB
26/43
KYAUKPYU
8/3
SANDOWAY
4/2
MANDALAY
21/9
NO. SHAN STATES
LASHIO
SAGAING
24/13
PAKOKKU
KYAUKSE
72
MYINGYAN
34/8
MEIKTILA
69/9
TAUNGGYI
50/16
SO. SHAN STATES
EA. SHAN STATES
LOI MWE
MINBU
21/5
MAGWE
48/8
YAMETHIN
24/30
THAYETMYO
11/10
LOIKAW
KAYAH STATE
TOUNGOO
14/4
PROME
24/8
SALWEEN
PAPUN
2/1
THARRAWADDY
39/21
HENZADA
42/8
PEGU
INSEIN
RANGOON
BASSEIN
38/15
MAUBIN
64/22
MYAUNGMYA
54/22
PYAPON
55/22
HANTHAWADDY
76/6
THATON
27/52
MOULMEIN
AMHERST
15/24
YE
15°
14°
13°
12°
11°
10°
98°
99°
THAILAND
TAVOY
5/25
MERGUI
3/23
ANDAMAN SEA
GULF OF SIAM

land behind the mangrove swamps are forests dominated by the kanazo tree. Large tracts of kanazo have been replaced by paddy-fields.

Nearly all of the area in which the annual rainfall is more than 40 inches but less than 80 inches is still covered with monsoon forests. The Pegu Yomas, the eastern slopes of the Arakan Yomas, and the Kachin State, except for the northern end, belong to this region. This belt is one of Burma's rich sources of forest wealth. Here are found teak, padauk, in, ingyin and other valuable woods.

The natural vegetation of the Dry Zone, with a rainfall of less than 40 inches a year and extremes of temperature, is largely small trees and scrub.

On the highlands of Burma, above 3,000 feet, grass and mountain forests thrive. The flat rolling plains of the Shan Plateau have broad grasslands, and the hilly regions of the northern and eastern hills have evergreen trees of the temperate region type.

C. AGRICULTURE

1. LAND RESOURCES

The land resources of Burma are highly suitable for richly productive agricultural activity. The economy revolves largely around agriculture. Its importance is reflected in the fact that roughly two thirds of the working population are engaged in the cultivation of land.

The most important crop, from the standpoints of both domestic consumption and export, is rice. For many years Burma was the largest single exporter of rice among all nations. If India was the jewel of the British Empire, Burma was its rice bowl.

The diversity of soil and of climate also favors the production of a relatively wide range of other agricultural products. At the present time, the most important farm products, next to rice, in approximate order of value of output, are groundnuts, tobacco, sesamum, sugar cane, pulses, rubber, onions, cotton, millet, chilli, maize, potatoes and wheat. The prospects for expanding the production of these commodities and others are favorable.

2. CLASSIFICATION INTO AGRICULTURAL REGIONS

In analyzing the agricultural resources of Burma, there is significance in the distinction between lower Burma and upper Burma, as indicated by the differences in soils and climate. The center of the transition zone between them lies approximately through the town of Thayetmyo, at 19° 20′ North latitude. An important distinction is that, in paddy production, lower Burma is generally a surplus area, whereas upper Burma is generally a deficit area.

A more refined classification into four agricultural regions is useful; namely, Lower Burma, Central Burma, Northern Burma, and the Shan and Kayah region. These divisions are indicated on Plate 2 and Table I–2, which present data on cultivated and cultivable land by districts. The large active and potential cultivation area in lower Burma testifies to the primary importance of this region in the agricultural economy.

TABLE I-2

LAND USE IN BURMA (1936 – 40)

	Cultivated and Fallow		*Culturable but not Cultivated*	
	1,000 acres	*Per cent*	*1,000 acres*	*Per cent*
Lower Burma				
Akyab	882	26	1432	43
Kyaukpyu	236	8	91	3
Sandoway	121	4	44	2
Prome	450	24	158	8
Tharrawaddy	704	39	377	21
Pegu	1163	45	142	5
Insein	591	49	218	19
Rangoon	—	—	—	—
Maubin	672	64	233	22
Henzada	758	42	133	8
Bassein	995	38	412	15
Myaungmya	994	54	394	22
Pyapon	761	55	28	2
Hanthawaddy	931	76	64	6
Toungoo	591	14	160	4
Thaton	829	27	1620	52
Moulmein (Amherst)	717	15	1147	24
Tavoy	190	5	874	25
Mergui	194	3	1634	23
Salween (Papun)	28	2	14	1
Central Burma				
Minbu	482	21	120	5
Thayetmyo	325	11	304	10
Magwe	1127	48	208	8
Yamethin	637	24	769	30
Meiktila	705	50	226	16
Myingyan	1189	69	157	9
Pakokku	858	24	452	13
Kyaukse	275	34	65	8
Mandalay	280	21	123	9
Sagaing	851	1·41	72	11
Monywa (Lower Chindwin)	914	3·43	39	15
Shwebo	1119	3·50	31	9
Northern Burma				
Falam	—	—	—	—
Upper Chindwin	182	2	1916	22
Naga Hills	—	—	—	—
Katha	—	—	—	—
Myitkyina	142	2	1612	17
Bhamo	47	2	808	31
Shan and Kayah States				
Northern Shan States				
Southern Shan States				
Eastern Shan States				
Kayah State				

Source: Season and Crop Reports.

3. LOWER BURMA

a. Climate

Lower Burma, encompassing 30% of the country's total area, includes the Arakan, Irrawaddy, Pegu and Tenasserim Divisions, comprising nineteen administrative districts. It extends from the fertile coastal strip of Arakan on the west, across the broad valley and great delta of the Irrawaddy and the valleys and deltas of the Sittang and Salween, to the long, narrow Tenasserim littoral in the southeast.

This is a humid tropical region, with relatively high temperature and a regular monsoon which provides average annual rainfalls ranging approximately from 80 to 220 inches per year. Less than a century ago most of the non-hill area in this expanse was a swampy and sparsely inhabited jungle. The trade opportunities provided by the opening of the Suez Canal transformed it into a rich and populous agricultural region.

b. Land Classification

Of the total land area of 52·6 million acres in Lower Burma, 22% was cultivated before the war. Another 21% was officially classified as cultivable. This formal classification includes forests, swamps and other lands suitable for agriculture only after draining, clearing and other improvement. Reserved forests comprise another 18% of the total area. These are rich and accessible forest lands carefully maintained by the Forest Department for commercial exploitation. Table I–3 presents data from Season and Crop Reports on land use in the divisions of lower Burma for the five-year prewar period.

TABLE I – 3

LAND USE, LOWER BURMA, 1935–36 to 1939–40

(thousands of acres)

Division	*Total Land Area*	*Reserved Forests*	*Other Land not Available for Agriculture*	*Cultivable but not Cultivated Land*	*Cultivated Land*	*Per cent of Total Land Area Cultivated*
Pegu	12,832	3,652	3,631	1,119	4,430	34·5
Irrawaddy	8,701	1,745	1,575	1,200	4,181	48·1
Arakan	11,065	462	6,170	3,181	1,252	11·3
Tenasserim	19,976	3,635	9,094	5,289	1,958	9·8
Total	52,574	9,494	20,470	10,789	11,821	22·5

c. Rice

The lower Irrawaddy valley and delta lie wholly within the Pegu and Irrawaddy Divisions, a circumstance which accounts for the fact that these two divisions contain almost three fourths of the cultivated land of lower Burma. This whole area is a vast patchwork of paddies—the great rice bowl of Burma. Also in the other fertile parts of lower Burma—along the Sittang and on the coastal strips of the Arakan and Tenasserim Divisions—rice is the dominant crop. About 90% of the total cultivated area of lower Burma is devoted to rice. Among the factors which make this whole region ideally suited for rice cultivation, the most important are the amount and regularity of rainfall. Most rice varieties are water plants that require several inches of standing water during most of the growing season. This can be accomplished in lower Burma by building up small mud embankments, or kazins, to retain the water during the long rainy season, from May to October, and to regulate its supply from field to field—a technique commonly known as "wet" cultivation.

d. Other Crops

As a whole, Lower Burma is a deficit area in other crops, which are imported from elsewhere in Burma or from abroad. However, some other types of cultivation are of considerable importance. The banks and islands of the rivers, which are annually flooded and silted but exposed during summer, are used to grow maize, millet and beans. Close to large consuming centers, the silt-covered lands are used for vegetable cultivation. Large portions of this alluvial or "kaing" land experience changes in surface, shape and size from year to year; sometimes large areas are washed away and reappear elsewhere. Such changing land is called "mye-nu" as distinguished from "mye-yin" which is permanent "kaing" land.

To a small extent in lower Burma, primitive "taungya" cultivation is practiced by the hill peoples. This type of cultivation consists of clearing patches of land by crude cutting, burning of vegetation, and sowing varieties of rice or other grains which will grow under these conditions. When the fertility is exhausted in two or three years, the process is repeated elsewhere. Such burned-over patches can be seen here and there on the hillsides of the Arakan Yomas and elsewhere in lower Burma. Fruit, palms, and chillies are also grown, and, in small quantities a variety of other crops.

It is worth noting that of the land brought under cultivation in lower Burma, the percentages of abandoned and fallow land are low. Especially in the case of rice, annual cropping is general. With proper rotation, if it were possible, the fertility of soil could be maintained. If the natural advantages of lower Burma are efficiently harnessed by an appropriate economic and social organization as well as by technology, the area could become one of the most productive regions in the world.

e. Rubber

All of Burma's rubber comes from lower Burma. Before the war, over 100,000 acres were devoted to rubber cultivation. The largest plantations are located in the Mergui and Tavoy Districts of the Tenasserim Division, although a few sizable estates are found in the laterite soils of the Southern Pegu Yomas and around Rangoon. Before the war there were some 3,700 small estates of less than 100 acres each, most of which were owned and operated by Burmans.

f. Forestry and Fishing

Lower Burma is also important for forestry and fishing products. The forests in the Pegu Yomas rank highest commercially. The southern portions are evergreen forests, but the greater part of these hills is clothed with monsoon forests, including teak. The main wooded areas are in the Prome and Toungoo Districts of the Pegu Division, the percentages of total area forested being 32 and 57 respectively. The teak reserves are more valuable here than elsewhere in Burma because of their accessibility and their proximity to the Port of Rangoon. The Arakan Yomas are covered with jungle, which is pine or rhododendron on the ridges, tropical evergreen forests on the western flanks, teak on the eastern, and thick damp undergrowth in the valleys. The coastal strip, as in the Tenasserim, has thick tropical evergreen forests and jungle covering the uncultivated areas. The Tenasserim is too wet for teak, however, it contains vast reserves of other hardwoods, almost totally unexploited. Both in Arakan and in the Tenasserim, as well as in the central regions of lower Burma, there are huge stands of bamboo which are an inexhaustible source of housing materials and cellulose for paper making and other products. Section D contains data on the forested areas and timber production for the various regions of Burma.

Because of its large water surface and because it contains the entire coastline of Burma, the production of fish in lower Burma is far greater than elsewhere in Burma, though small-scale fishing occurs throughout the country in rivers and creeks and somewhat larger scale operations are carried out in a few places, such as Inle Lake near Taunggyi in the Southern Shan States. Fish are the second most important product of Arakan. A considerable fishing industry also exists in the southwest delta around Bassein. Fishing abounds along a large part of the Tenasserim coast, and Tavoy and Mergui are especially famous in Burma for their salt fish and for ngapi and other forms of fish paste.

4. CENTRAL BURMA

Central Burma, the Dry Zone, extends south from Shwebo to the Thayetmyo and Yamethin Districts. Between these, the other districts included are Lower Chindwin, Mandalay, Kyaukse, Pakokku, Myingyan, Meiktila, Minbu, and Magwe. This region receives less than 40 inches of rainfall per year. However, the irregularity of precipitation rather than the quantity shapes the nature of the cultivation. When the rains occur, they come in such downpours that most of the water is received in extremely brief intervals. If the rainfall was spread more evenly, this would not be a "dry zone," and agriculture would be much more productive.

Dry land cultivation is widely practiced in this area, but "kaing" cultivation and irrigation also exist. Although there are no extensive modern projects, irrigation systems have existed since early Burmese days.

Rice is an important crop even in the Dry Zone. Most of it is grown in irrigated tracts. Shwebo, Mandalay, Kyaukse and Yamethin districts are the centers of rice cultivation, but it is grown in some measure throughout the region. Groundnuts, pulses, sesamum, millet, and cotton are other major crops, and maize, gram, fruits, vegetables and sugar cane are grown. Because of the uncertainty of rainfall, farmers try to insure themselves against crop failures by diversity of crops.

5. NORTHERN BURMA

Northern Burma includes the administrative districts of Upper Chindwin, Katha, Bhamo, Myitkyina, the Naga Hills, and the Special Division of the Chins. The region is generally hilly and wooded and most of it is sparsely populated. The Special Division of the Chins, the northern part of Myitkyina, and the hilly portion of the Naga Hills district are clothed with dense hill forests. Bhamo, Katha, Upper Chindwin, and the remainder of Myitkyina, which also contain forested areas, belong to a wet zone that is similar in some respects to Lower Burma.

Over two thirds of the cultivated area is under rice. Most agricultural production is for local consumption, but in some parts of the broad northern valleys of the Irrawaddy and its tributaries surpluses of rice and sugar cane are produced. Most of the land cultivated or suitable for cultivation is in the Myitkyina-Bhamo-Katha triangle. Sizable tracts exist elsewhere. The area extending northwest from Homalin up to and including the Hukawng Valley, except for the highlands, though not now cultivated, is topographically suited to agriculture. In the unoccupied valleys of this region there are some 2,000,000 acres of well-watered land.

6. THE SHAN AND KAYAH REGION

The Shan and Kayah States represent a distinctive agricultural region. The grasslands are the most important part of the Shan Plateau. Wet cultivation and taungya cultivation are practiced, the former in the valleys and on the plains and the latter on the hillsides.

In the valleys and on the plains, rice and temperate crops such as wheat, potatoes, and other vegetables and fruits are grown. Tea is an important crop, mostly grown on the hills. Almost all of the garlic and ginger of Burma, much used by the Burmese to flavor their curries, are produced in the Shan States. This area is also the main source of supply of domestic animals—cattle, horses, sheep and goats—for other regions of Burma, especially draft animals for Lower Burma.

Most of the hilly parts of the Shan and Kayah Region have valuable forests, which as yet are largely untapped. In particular, the valleys in the southern portions of this region contain valuable teak forests.

D. FORESTS

1. PRODUCTS

The forests of Burma constitute an extremely valuable national asset. Timber, bamboo, and thatch are the basic materials used for housing and other construction. Firewood, charcoal, cane, bark for tanning and medicinal uses, cutch, lac, and thitsi (a gum used for lacquer work) are other major products of the forests. Teak, other hardwoods, cutch and lac are exported. Burma has been the world's foremost exporter of teak, which is her second most valuable postwar export: prewar it ranked fourth.

2. ACREAGE CLASSIFICATION

Table I–4 presents the forest acreage of Burma as currently classified by the Working Plans Circle of the Office of the Conservator of Forests. Burma is divided into six forest circles, which again are subdivided into forest divisions. Data with respect to the forests within each division are classified

TABLE I – 4*

FORESTS OF BURMA

(thousands of acres)

1 *Circle and Division*	2 *Teak* *Reserved*	 *Unclassed*	3 *Other Hardwoods* *Reserved*	 *Unclassed*	4 *Reserved for Local Supply*	5 *Reserved for Fuel for B.R., I.W.T.B. Etc.*	6 *Reserved Unalloted*	7 *Total* *Reserved*	 *Unclassed*
Maritime Circle									
Arakan	—	—	215	855	56	67	124	462	855
Henzada	193	—	—	—	7 (116)	—	365	565	—
Bassein	—	—	109	—	18	164	217	508	—
Delta	—	—	706	—	—	—	—	706	—
Thaton	282	2,646	— (91)	— (744)	— (60)	—	—	282	2,646
Ataran	622	1,510	— (352)	— (1,540)	— (2)	—	19	641	1,510
Thaungyin	329	64	116	—	—	—	82	526	64
Tavoy	—	—	2,098	—	43	55	—	2,197	—
Total	1,426	4,220	3,244 (443)	855 (2,254)	124 (178)	286	807	5,887	5,075
Hlaing Circle									
Thayetmyo	636	1,580	— (133)	—	—	—	—	636	1,580
Allanmyo	138	290	3 (94)	—	19	—	—	160	290
Prome	259	322	5 (149)	—	66 (6)	—	—	330	322
Zigon	270	—	7 (104)	—	14	—	—	291	—
Tharrawaddy	170	—	— (34)	—	51	—	—	221	—
Insein	237	—	— (237)	—	48 (6)	7	10	302	—
Total	1,710	2,192	15 (751)	—	198 (12)	7	10	1,940	2,192

TABLE I – 4* (*contd.*)

1	2		3		4	5	6	7	
Circle and Division	*Teak*		*Other Hardwoods*		*Reserved for Local Supply*	*Reserved for Fuel for B.R., I.W.T.B. Etc.*	*Reserved Unalloted*	*Total*	
	Reserved	*Unclassed*	*Reserved*	*Unclassed*				*Reserved*	*Unclassed*
Sittang Circle									
Yamethin	426	70	— (149)	—	61 (8)	—	—	487	70
Pyinmana	456	250	— (275)	—	— (21)	—	13	469	250
North Toungoo	314	321	— (176)	—	1 (18)	— (2)	11	326	321
South Toungoo	621	1,486	3 (64)	—	55 (26)	—	6	685	1,486
North Pegu	512	39	3 (74)	—	30 (21)	—	4	549	39
South Pegu	528	—	— (302)	—	43	15	—	586	—
Total	2,857	2,166	6 (1,040)	—	190 (94)	15 (2)	34	3,102	2,166
Northern Circle									
Myitkyina	436	2,285	—	—	1 (46)	179	—	616	2,285
Bhamo	497	1,271	31 (202)	719	2 (46)	—	—	530	1,990
West Katha	1,182	3,482	— (275)	—	—	—	—	1,182	3,482
East Katha	519	431	— (291)	151 (431)	19 (13)	—	27	565	582
Shwebo	815	1,926	143 (386)	—	44 (28)	—	—	1,002	1,926
Maymyo	499	659	40 (88)	—	69 (26)	—	50	658	659
Total	3,948	10,054	214 (1,242)	870 (431)	135 (159)	179	77	4,553	10,924
Chindwin Circle									
Upper Chindwin	877	996	17 (3)	—	—	—	21	915	996
Myittha	543	1,050	33	—	12	—	92	680	1,050
Lower Chindwin	457	72	128	893	—	—	—	585	965
Meiktila	255	—	58 (160)	—	230 (83)	—	114	657	—
Yaw	647	1,058	38 (553)	—	78 (11)	—	—	763	1,058
Minbu	671	442	87 (625)	—	35	—	318	1,111	442
Total	3,450	3,618	361 (1,341)	893	355 (94)	—	545	4,711	4,511
Shan States									
Mongmit	631	998	47 (148)	—	—	—	29	707	998
N. Shan States	237	1,730	58 (126)	—	5 (5)	—	—	300	1,730
S. Shan States	512	4,805	— (23)	—	15	—	473	1,000	4,805
Total	1,380	7,533	105 (297)	—	20 (5)	—	502	2,007	7,533
Unclassed Forests not Assigned to Working Circles									41,896
Grand Total	14,771	29,783	3,945 (5,114)	2,618 (2,685)	1,022 (542)	487(2)	1,975	22,200	74,297[+]

---

[*] Figures in parentheses columns 3, 4, and 5 represent areas that overlap with those given in column 2; they are not therefore, included in the total in column 7.

[+] The Unclassed Grand Total equals Total Unclassed for Teak and other Hardwoods, and Unclassed Forests not Assigned to Working Circles.

into one or more of the following groupings, according to the main uses for which the forests are intended:

Teak Selection Working Circle—primarily teak forests.

Commercial Supply Working Circle—primarily other hardwood forests.

Local Supply Working Circle—forests reserved for use of villages in the vicinity, and controlled to prevent destructive exploitation by villagers.

Other Working Circle—forests reserved for fuel for the railways and the Inland Water Transport Board for rafting poles and for other special purposes.

Unallotted—forests reserved for climatic reasons; commercially valuable but inaccessible forests reserved for future exploitation; remote forests about which little is known; miscellaneous forests.

The second and third and to a small extent the fourth working circles listed above overlap with the first, i.e., some of the forest areas are assigned more than one use. This is shown by the figures in parentheses in columns three, four, and five of Table I–4 which represent areas that overlap with those given in the second column; they are not, therefore, included in the total in column seven.

Forests falling under the Teak Selection and Commercial Supply Working Circles are further divided into reserved and unclassed forests as indicated in the table. The reserved forest areas are more valuable in terms of such characteristics as number of trees, quality of timber, and accessibility, and are generally intended as a perpetual commercial source of supply. Like the forests falling under the other working circles, these are closely administered by the Forest Department, and exploitation is carefully regulated. The unclassed forests are loosely administered, if at all. Some unclassed forests are not assigned to any of the working circles.

A map showing the location of all reserved forests in Burma is included in Chapter XXII.

3. WOOD PRODUCTION

Production of teak and collectively of all woods other than teak (which are almost entirely hardwoods) each averaged roughly half a million cubic tons per year immediately before World War II. It is generally thought that with respect to teak this amount represents the maximum sustainable rate. In the case of other hardwoods, the supply is potentially much greater than half a million cubic tons annually. The limitations are markets and accessibility of the forest areas. One of the problems of accessibility is that most other hardwoods, unlike teak, do not float, and must be transported overland or by bamboo rafting on the larger waterways.

Burma has a long history of careful protection and administration of its forests. A large forest service is manned by experienced personnel. The war and subsequent insurrections have seriously inhibited the work of the Forestry Department. The production of timber, likewise, has been drastically reduced. Because of the remoteness of forests and the need for long supply lines in backwoods areas, timber extraction is one of the industries most affected by the prevalent sporadic fighting.

TABLE I – 5

PRODUCTION OF MAJOR MINERAL PRODUCTS IN 1939*

(All figures are in thousands)

Location	*Mineral*	*Quantity*
Tenasserim Division		
Thaton	Tin and Tungsten Concentrates	0·2 tons
Amherst	,,	0·1 tons
Tavoy	,,	6·7 tons
Mergui	,,	2·4 tons
Mandalay Division		
Yamethin	,,	0·4 tons
Kayah State	,,	5·6 tons
Arakan Division		
Kyaukpyu	Petroleum	11·1 gals.
Magwe Division		
Magwe	,,	246,706·5 gals.
Pakokku	,,	22,127·1 gals.
Minbu	,,	2,818·2 gals.
Thayetmyo	,,	1,996·4 gals.
Sagaing Division		
Upper Chindwin	,,	2,014·1 gals.
	Total Petroleum	275,673·4 gals.
Northern Shan States	Ore†	486·9 tons
(Bawdwin Products)	Zinc Concentrates	59·3 tons
,,	Refined Lead	76·0 tons
,,	Copper Matte	7·9 tons
,,	Nickel Speiss	2·9 tons
,,	Antimonial Lead	1·2 tons
,,	Refined Silver	6,175·0 troy ozs.
,,	Tin and Tungsten Concentrates	15·4 tons
	Total Concentrates and Refined Metals (Exclusive of ore)	1,431·1 tons

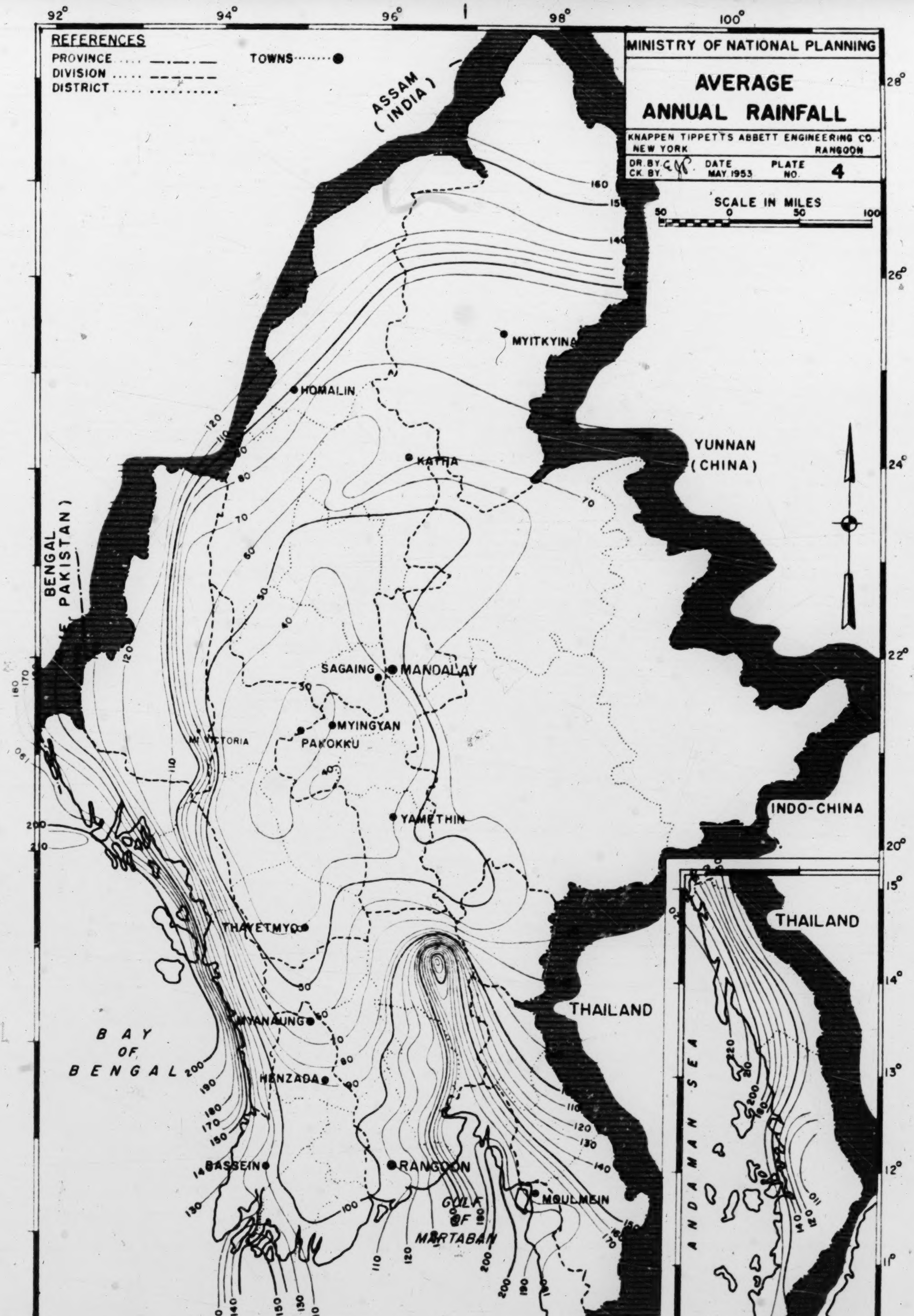
* Source: "Report on Mining and Mineral Production in Burma," 1939. The following approximate quantities of other minerals (except salt) were reported by the same source as produced in 1939

Building stone and road metal	2,564,441 tons
Salt	57,000 tons
Petrol from natural gas	36,005 tons
Iron ore (Flux for Bwdn. smelter)	26,259 tons
Clay for pottery	16,343 tons
Soap-sand	1,878 tons
Antimony	325 tons

Quartz	100 tons
Bismuth	8 cwts.
Jadeite	767 cwts.
Amber	6 cwts.
Gold	1,206 ozs.
Rubies	211,570 carats
Sapphires	10,532 carats

† The ore is the source of all other Bawdwin products and is omitted from the total.

In calculating the totals, silver is converted to tons at the rate of 32 667 troy ounces per ton.



MINISTRY OF NATIONAL PLANNING

AVERAGE ANNUAL RAINFALL

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY
CK. BY.
DATE MAY 1953
PLATE NO. 4

REFERENCES
PROVINCE
DIVISION
DISTRICT
TOWNS
SCALE IN MILES
50
0
50
100
ASSAM (INDIA)
BENGAL (E. PAKISTAN)
YUNNAN (CHINA)
INDO-CHINA
THAILAND
THAILAND
BAY OF BENGAL
ANDAMAN SEA
ANDAMAN SEA
GULF OF MARTABAN
GULF OF SIAM
MYITKYINA
HOMALIN
KATHA
SAGAING
MANDALAY
MYINGYAN
PAKOKKU
VICTORIA
YAMETHIN
THAYETMYO
MYANAUNG
HENZADA
BASSEIN
RANGOON
MOULMEIN
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94°
96°
98°
100°
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96°
98°
98°
99°
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110

E. MINERALS

1. MINERAL DEPOSITS

The importance of Burma's mineral resources is indicated by the fact that, prior to World War II, the value of mineral exports including petroleum products was equal to about four fifths of the value of rice exports and constituted over one third of the total value of exports.

The three principal regions of Burma which include practically all the sources of economic mineral production, excepting petroleum, thus far known are: the Shan State and contingent areas including the Kayah, Kentung and Wa States; the Kachin State, including the Naga Hills, North Burma, and the Upper Chindwin country; and the Tenasserim Division.

Although there are many minerals in Burma, those deposits which hitherto have proved of greatest economic value are tin, tungsten, lead-silver and petroleum.

A more detailed review of the mineral deposits of Burma and a discussion of their potentialities may be found in Chapter XXI.

2. PRODUCTION

The data on 1939 production, presented in Table I–5 and its footnotes, indicate the prewar pattern of mineral exploitation. Included are references to the products of the Burma Corporation smelter at Namtu (near Bawdwin), the only large metal refining operation in Burma prior to the war. All of the approximately 275-million-gallon prewar annual production of petroleum was refined within Burma.

Many important mineral deposits are now inaccessible because of insurgency. As a result, present production is far below prewar production. Petroleum production has been below the domestic requirement.

F. WATER RESOURCES

1. RIVERS

The main river systems of Burma are shown on Plate 4. A description of these systems follows:

a. Irrawaddy River

(1) General

The Irrawaddy rises at about 28° North latitude, in a major extension of the Himalaya Mountains, having permanent snow fields and peaks over 19,000 feet above sea level. The river flows generally southward 1,300 miles to its mouth on the Bay of Bengal, 16° North latitude. The total drainage area is 155,000 square miles, including 15,000 square miles of delta area.

(2) The Delta

This has a maximum width (east–west) of 200 miles and a maximum length of 150 miles. The principal water use is for agriculture and navigation. In certain Rangoon areas clear potable water originates in sand beds 280 feet below ground level and rises to a depth of 30 feet. An artesian condition exists north of Rangoon, at the Government Spinning Mill. South of Henzada, the delta has several outlets to the sea through meandering channels. It is flat, poorly drained, and receives intense rainfall during the monsoon season. Many areas are subject to inundation during the monsoon season, despite numerous protective levees, normally effective. Additional physical data for the Irrawaddy River are given in Table I–6.

TABLE I – 6

THE IRRAWADDY RIVER

Locality	*Miles Upstream*	*Max. Flood Flow (thous. c.f.s.)*	*Drainage Area (sq. mi.)*	*Annual Output (thous. ac. ft.)*
Mouth of China Bakir River	0	—	155,000	310,000
Myanaung	218	2,000	140,000	280,000
Confluence Chindwin and Irrawaddy	559	—	117,870	260,000
Mandalay	670	—	48,160	140,000
Katha	890	—	32,400	119,000
Irrawaddy Confluence	1,160	—	17,900	90,000
Source	1,290	—	—	—

(3) The Central Valley

North of Henzada the Central Valley extends 250 miles to Pakokku, varying in width from 60 miles near its south end to 160 miles at Pakokku. The rainfall varies from 90 inches per year near the south end to about 30 inches at Myingyan. Irrigation is required as far south as Thayetmyo, water being obtained from numerous perennial flowing tributaries entering from the Arakan and Pegu mountains. The principal streams in this group are listed in Table I–7.

TABLE I – 7

CENTRAL IRRAWADDY TRIBUTARIES

River	*Length in Miles*	*Elevation at Source*	*Drainage Area (sq. mi.)*	*Low Flow (c.f.s.)*	*Annual Output (thous. ac. ft.)*
Matun	116	3,750	1,670	—	1,690
Man	78	4,250	717	20	725
Mon	196	10,000	2,314	160	2,340
Salin	94	8,500	1,350	20	—
Yin	—	2,000	2,410	—	1,540
Pin	—	5,000	1,014	—	—
Yaw	148	8,750	2,575	—	11,900

(4) The Northern Basin

The northern Irrawaddy basin, including the Chindwin, Mu, Shweli and Myitnge Rivers, contains vast power and irrigation resources (see Chapters IX and XIX). Commercial navigation exists on the main Irrawaddy River to Myitkyina and to Homalin on the Chindwin. Irrigation is desirable over the lower part of the northern basin and minor projects have been developed in the Mandalay, Shwebo, Kyaukse and Sagaing Divisions (see Chapter IX).

b. Arakan Rivers

West of the Irrawaddy Valley lie the coastal mountains extending from low foothills near Bassein (lat. 16°) to the Indian Border (lat. 24°). The foothills, termed the Arakan Yomas, increase steadily toward the north culminating in 10,000-foot Mount Victoria (lat. 21°). North of this peak there is a continuous range of mountains, 8,000 to 9,000 feet in height, terminating in the rugged Chin Hills. The coastal mountains are heavily watered. Proceeding from the southern extremity, the principal rivers on the west slope discharging directly into the Bay of Bengal are indicated in Table I–8.

TABLE I – 8

ARAKAN RIVERS

River	*Length in Miles*	*Elevation at Source*	*Drainage Area (sq. mi.)*	*Annual Output (thous. ac. ft.)*
Lemro	168	5,500	3,910	20,300
Kaladan	404	8,000	8,730	43,600
Mayu	96	2,000	1,975	9,200

c. Pegu River

East of the Irrawaddy Central Valley, separating it from the Sittang River, lie the Pegu Yomas, a range of low mountains about 150 miles in length. Out of the southern portion and discharging into the Rangoon River, flows the Pegu River. The total length of the river is 166 miles and its elevation at the source is about 2,700 feet. The drainage area is 2,065 square miles and average annual output 6,500,000 acre feet. In view of its proximity to the Rangoon market, high annual runoff, and adequate storage possibilities the Pegu has promise as a source of hydroelectric power which can be scheduled for early development (see Chapter XIX).

d. Sittang River

The Sittang River originates near Yamethin (lat. 20° 15′), at elev. 1,500 feet, and discharges into the Gulf of Martaban (lat. 17° 15′) about 60 miles east of Rangoon. The river parallels the Irrawaddy in its southward flow. It has a valley length of about 200 miles and a width of 40 to 50 miles. The drainage area is 13,280 square miles and annual output 34,000,000 acre feet. Numerous large tributaries having good sustained flow enter the river from both east and west. Several have sufficient output and head to be considered for irrigation and power. Among these are the Shwegyin and Kyaukkyi, discussed in existing reports as potential power streams in conjunction with diversion of water from the Yunzalin drainage. Installations up to 150,000 horsepower have been contemplated, to supply power to Rangoon and other "central valley" towns (see Chapter XIX).

e. Bilin River

East of the Sittang and flowing parallel thereto is the Bilin River, 935 square miles drainage area and 5,000,000 acre feet annual runoff. Its source is at elev. 4,500 feet, and its outlet is the Gulf of Martaban. The valley length is about 100 miles and maximum width 20 miles. Flow is well sustained in the rainy season with over 150 inches of annual rainfall. The river is a possible source of power, although somewhat remote from load centers.

f. Salween River

Farther east is the Salween River, which crosses the China–Burma boundary at River Mile 760 and stream bed elev. 2,000+ ft. Thence it flows in a southerly direction discharging into the Gulf of Martaban at Moulmein. The river has an average gradient of 2·6 feet per mile without notable falls. Throughout most of its length in Burma the river flows in a major canyon, and numerous large tributaries enter by steep channels or sizable cascades. Consequently, the power potentialities on the tributaries are very large, but located far from

TABLE I – 9

MAJOR TRIBUTARIES OF SALWEEN RIVER

River	*Drainage Area (sq. mi.)*	*Annual Output (thous. ac. ft.)*
	Western Tributaries	
Donthami	1,090	5,200
Yunzalin	1,130	6,000
Nam Pawn	7,290	16,300
Nam Teng	5,880	14,100
Nam Pang	4,890	12,500
	Eastern Tributaries	
Ataran	2,200	11,700
Gyaing	3,680	19,400
Nam Hsim	1,980	4,400
Nam Hka	3,980	8,900
Nam Ting	3,460	8,900

existing markets. The downstream 70 miles of the Salween is located in an alluvial plain where meanderings and alternate channels exist. The river is navigable in this lower reach, and is said to be passable part of the year for small boats proceeding downstream from the China border to the sea (see Table I–9).

g. Tenasserim Rivers

In the panhandle south of Moulmein are the Great Tenasserim and a number of small rivers where navigation will be the principal use. However, there are power sites suitable for local supply, where 200- to 250-inch rainfall occurs annually (see Table I–10).

TABLE I – 10

TENASSERIM RIVERS

River	*Drainage Area (sq. mi.)*	*Annual Output (thous. ac. ft.)*
Lenya	1,230	6,900
Great Tenasserim	6,840	41,600
Tavoy	1,110	6,900

2. PRECIPITATION

The average annual precipitation for all parts of Burma, obtained from long-term records of the Ministry of Agriculture and Forests, is shown on Plate 4. The rainfall varies from 200 inches or more on the Arakan and Tenasserim coasts to a low of 30 inches on the area near Chauk and Myingyan. At the sources of the Yunzalin River (elev. 8,500 ft.) the average rainfall is 224 inches, and in North Burma it averages 160 inches near the Irrawaddy and Chindwin sources.

The monthly distribution of rainfall throughout the average year is shown for selected stations in Table I–11.

3. RUNOFF

Estimated runoff factors vary from 20% in the dry belt to 75% in the Kachin States. The estimated factors are based on recorded discharge and rainfall for the Rangoon Water Supply Reservoir at Gyobbyu, and for the Bawgata hydroelectric project where stream-flow measurements were made in 1947–48. Based upon available rainfall and discharge records, the runoff factor for the Pegu watershed above Pegu Town varied from 49·5% to 70·6% for the period 1946–52, with an average of 60·7%. The runoff factor for the Saingdin Drainage Area has been computed to be 55·7% for 1952. More detailed runoff data are given in Chapter IX.

4. IRRIGATION

A detailed description of the over-all irrigation program and specific projects may be found in Chapter IX.

5. NAVIGATION

Seasonal navigation is developed on the Irrawaddy as far north as Myitkyina and on the Chindwin to Homalin. Navigation extends 70 miles up the Salween. A complete system of channels connects all tidal rivers of the Irrawaddy Delta so that barge movement of rice to the deep water ports is customary. Numerous tidal estuaries and rivers on the Arakan and Tenasserim coasts are suitable for navigation. The Sittang River entrance is made troublesome by a bore; however, this area is by-passed by the

TABLE I – 11

MONTHLY AND ANNUAL MEAN RAINFALL AT SELECTED STATIONS

District	*Jan.*	*Feb.*	*March*	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Year*
Rangoon	0·2	0·2	0·3	1·6	12·0	18·0	21·4	19·9	15·3	6·9	2·8	0·4	99·0
Mergui	0·9	2·0	3·1	5·3	16·9	29·4	31·6	29·2	26·4	12·1	3·7	0·7	161·3
Akyab	0·1	0·2	0·5	2·1	14·0	46·9	54·8	45·2	22·6	10·9	5·5	0·8	203·6
Myitkyina	0·4	0·9	0·9	2·0	6·0	15·1	19·2	15·5	9·7	6·8	1·2	0·4	78·1
Toungoo	0·1	0·3	0·2	1·9	7·7	14·1	17·6	19·1	12·1	7·4	1·8	0·5	82·9
Tharrawaddy	0·1	0·3	0·2	0·8	8·8	16·5	21·1	19·9	12·8	5·6	2·0	0·4	88·5
Prome	0·0	0·1	0·1	0·8	5·5	8·8	9·0	9·0	7·2	4·5	1·7	0·2	46·9
Meiktila	0·1	0·1	0·2	0·8	5·2	4·9	3·4	4·7	6·3	5·5	1·9	0·4	33·5
Maymyo	0·1	0·2	0·5	2·1	9·7	8·9	6·3	9·3	10·2	7·6	3·3	0·6	58·8
Lashio	0·3	0·3	0·6	2·2	6·9	9·8	12·0	12·7	7·8	5·7	2·8	0·9	62·0
Thayetmyo	0·0	0·0	0·1	0·7	5·3	7·9	8·0	8·5	7·8	4·9	2·3	0·0	45·5
Mandalay	0·1	0·1	0·2	1·1	5·9	5·5	3·3	4·6	5·7	4·7	1·6	0·4	33·2

Pegu-Sittang Canal bringing small boats from the Sittang into the Rangoon River. A detailed description of the navigability of the river systems of Burma is contained in Chapter XIII.

G. TRANSPORTATION

1. WATERWAYS

The Irrawaddy system constitutes the country's chief means of inland waterways transport. The main river is navigable for 900 miles throughout the year, and for 105 additional miles during seven months of each year. Its great tributary in the northwest, the Chindwin, is navigable for 400 miles. In the south, the delta formed by the mouths of the Irrawaddy is a vast maze of minor rivers and streams. These form 1,500 miles of commercially navigable waterways throughout the year. Another 300 miles are added by the connected Rangoon River and its tributaries. These, plus innumerable other little streams used by small craft, form a network which provides the primary and in many places the only channel for travel and trade—short and long distance —throughout the region.

The Kaladan-Lemro rivers and their tributaries in northwestern Arakan constitute a separate and important system of inland waterways—commercially navigable for 350 miles, and more on tide. Including smaller streams usable by country boats, this is virtually the only method of transport in the area.

The Sittang is not navigable at its mouth, and the Salween for only 55 miles from its mouth. The Great Tenasserim and Tavoy rivers likewise have limited navigation possibilities. These waterways and various minor coastal streams in the Tenasserim are significant only for local traffic.

Both large and small waterways in Burma are affected by tides for considerable distances inland. Even commercial transportation can be significantly extended when it is timed with high tides. Also, a marked seasonal expansion of navigable waterways occurs during the five to seven months of high water during and after the rains.

There are only a few scheduled carriers in the coastal waters. The Government is developing a scheduled coastal service. One ship now operates between Rangoon and Arakan ports. When other ships which are on order are received, the service will be extended to the Tenasserim.

2 RAILWAYS

Prior to World War II, there were 2,060 route miles of government-owned railway of excellent standards. Owing to destruction by the Japanese and insurgent operations, only some 1,500 miles are presently in operation. Rehabilitation is planned to a total of about 1,900 route miles by 1954. Existing lines and those to be rehabilitated are shown on the map, Plate 2 of Chapter XI.

The main lines extend 161 miles up the Irrawaddy Valley from Rangoon to Prome and 385 miles up the Sittang and Samon valleys from Rangoon to Mandalay. From Mandalay, one branch continues northward to Myitkyina and another extends 176 miles northeast to Lashio in the Northern Shan States.

There are three junction points for branch lines on the main Rangoon-Mandalay line. At Thazi, below Mandalay, branch lines run northwest to Myingyan on the Irrawaddy River and east to Shwenyaung in the Southern Shan States, 20 miles short of Taunggyi. Farther south at Pyinmana, a branch line originally extended northwest to Kyaukpadaung, but it will not be rehabilitated for traffic until 1954.

Pegu is the initial point for a branch line running southeast to Martaban on the Salween River across from Moulmein. From Moulmein an isolated branch carries little traffic a hundred miles south down the Tenasserim coast to Ye.

From Letpadan, about midway on the Rangoon–Prome line, a branch extends westward to Henzada on the Irrawaddy. Traffic is ferried across the river whence forks go north to Kyangin on the Irrawaddy and south to the seaport town of Bassein. Other short branches complete the system.

3. HIGHWAYS

There are about 6,000 miles of highways and main roads. These are indicated on the map, Plate A of Chapter XVI. Nearly two thirds of these roads are tarred or metaled, and are motorable in all seasons ; the rest only in good weather. Among the main national highways motorable in all seasons are the Rangoon-Mandalay-Lashio-Bhamo (a fair-weather road extends to Myitkyina), Rangoon-Prome-Mandalay, the Moulmein-Mergui (between Amherst and Ye the road is fair weather only), the Sagaing-Shwebo-Monywa-Sagaing (a fair-weather extension exists from Shwebo to Kalewa-Tamu), and the Meitktila-Taunggyi-Kentung (an all-weather road continues to the Thailand border).

4. AIRWAYS

There are at present 32 airfields in addition to the new Mingaladon airport. These are of varying lengths and surfaces. Some of them are serviceable only in the rainless months. All scheduled domestic service is by the government-owned Union of Burma Airways. All services radiate from Rangoon, departing from and returning to Rangoon on the same day. UBA maintains daily services from Rangoon to Bassein, Myaungmya, Moulmein, Thaton and Mandalay. It provides weekly or semi-weekly services between Rangoon and Lashio, Magwe, Lanywa, Meiktila, Pakokku, Heho, Kentung, Shwebo, Loikaw, Myitkyina, Tavoy and Mergui.

5. INTERNATIONAL TRANSPORT

Because Burma is hemmed in on the east, north, and west by mountain barriers, land traffic to or from bordering countries is negligible. Three mountain roads represent the only land communications of any consequence: the road to Thailand through Kentung; the Burma Road through the Northern Shan States leading to Yunnan; and the war-built Ledo Road winding through the northern hills into Assam. Most international traffic is carried by sea and by air, and mainly under foreign flags. The Union of Burma Airways has flights to Calcutta, Penang and Singapore. Many international airlines operate from Rangoon. Several sea-going ships are on order for inaugurating a governmental shipping service to India.

H. CAPITAL RESOURCES

Centuries of productive effort in Burma have added large amounts of man-made capital to her natural resources; yet she is still markedly deficient in modern productive equipment.

1. PREWAR CAPITAL

Comprehensive data on prewar capital do not exist. However, its general nature and the role it played are well known. The clearing of forests and jungle and construction of embankments, canals, and irrigation ditches constituted capital improvements in the land which accounted for much of its value. Together with agricultural equipment and livestock and with the buildings on agricultural lands, these improvements formed a greater stock of capital than existed in any other single group of economic activities. Considerable capital value resulted also from the work which had been done in opening up forests for timber extraction and developing mines and wells. The development and improvement of roads, ports and waterways, and railroads represented a sizable investment, and served the needs of the prewar economy. Rice and timber mills, three oil refineries, a cement plant, and a large smelter were the only large-scale processing facilities, but small-scale and cottage industries, together with wholesale and retail trade and a variety of service establishments had built up a large stock of capital, though much of it was crude and outmoded. In other sectors as well, much of the equipment and facilities was obsolete. Transport, crude material extraction, large industry, and the impoverished agricultural sector stood in need of technological improvement in varying degrees.

2. WAR DAMAGE

This modest capital structure was largely demolished by the war. Industrial facilities were razed, oil wells plugged and mines flooded. Irrigation systems, forests, and agricultural lands deteriorated for lack of upkeep. The transport system, which bound the country together effectively before the war, suffered extensive damage. Telecommunications facilities were almost completely destroyed.

3. RECONSTRUCTION

Since the war reconstruction has just begun to out-pace the ravages of postwar civil insurrection. Most of the rehabilitation, however, has taken the form of makeshift reconditioning of old installations along old lines. A few of the more modern prewar enterprises are now being rejuvenated on an up-to-date basis—a Burmah Oil Company refinery, the Bawdwin mines and smelter, and the cement plant at Thayetmyo. In addition, several new investment projects have been undertaken by the Government. The Mingaladon Airport is a first-class aerodrome, and a modern State Cotton Spinning and Weaving Factory has been constructed and placed in operation.

For the most part, however, the capital resources of Burma are inferior to those of prewar both in quantity and quality; meanwhile, technological advance elsewhere in the world has widened the gap between Burma and the more highly industrialized countries. The value in 1952 of all capital improvements and equipment in Burma may be estimated at between K10,000 and K15,000 millions. The rate at which this store of productive equipment is increased, and the quality of the new capital, will in large part determine the success of the development program.

I. HUMAN RESOURCES

Of all the economic resources of any country, by far the most important are the skill, energy, organization, and morale of the people. Where the inhabitants have been able and willing to apply themselves skillfully, much has been achieved even with meager resources. Where the people have been untrained or without initiative, great physical resources have not prevented national poverty. Any summary of the economic potentialities of Burma must therefore appraise the country's human resources.

1. SIZE

The latest over-all data on the Burmese labor force are those of the 1931 census; the 1941 census results, except for some summary information, were lost during the war. The first stage of a new census, whose three stages will require at least three years, has just been completed and some preliminary results are available. However, it is only a partial tabulation limited primarily to the accessible large towns, and its results should not be taken as representative for the country as a whole.

The results of earlier censuses indicate that in the past about 45% of the total population were in the working group. In 1941, the total population of Burma was 16·8 million, the increase over 1931 due to births and deaths being estimated at about 14%, or 1·3% per year. At this rate of increase the 1953 population would be 19·7 million. However, net emigration, probably fewer births due to disturbed conditions, and higher death rates due to war and insurrection, suggest a figure of about 19 million. At this level of population, the earlier 45% worker-population ratio, which probably has not changed radically, indicates a present labor force of about 8·5 million workers.

The population will probably increase more rapidly in the future than before the war because of a lowering of the death rate, especially the infant mortality rate, which will accompany improvements in preventive and remedial health services. A decline in the birth rate may also occur, but not until a later period. The percentage of the population which is in the labor force will be influenced downwards because a rapidly increasing population implies a greater proportion of younger non-workers, periods of education and training for children will be longer, and perhaps a decreasing death rate will have a greater immediate effect on the very young and the very old than upon persons of working age. The size of the labor force may be expected to increase at about the same rate as in the past, to about 9·3 million workers in 1960.

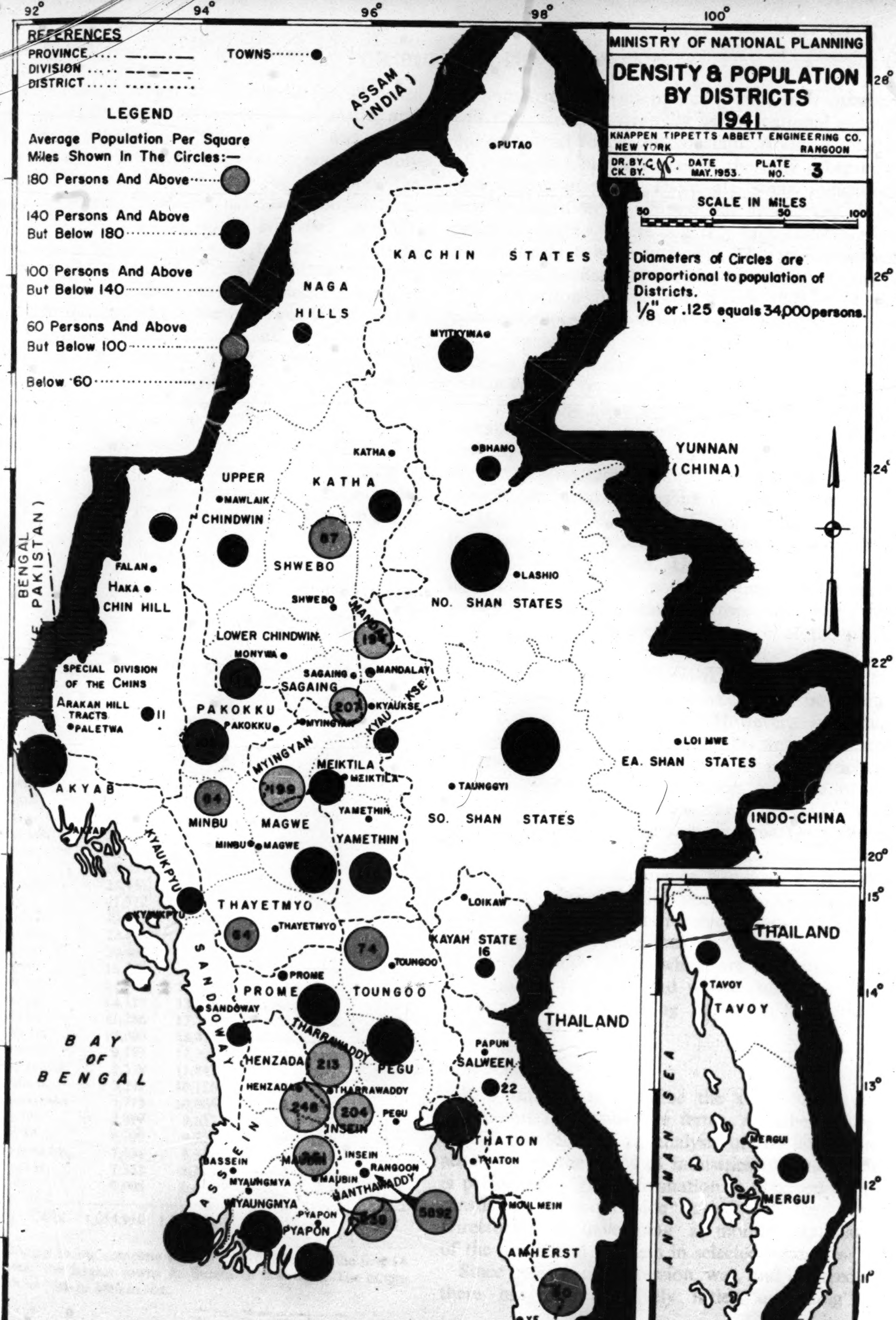
Burma is sparsely populated relative to its natural endowments and in comparison with neighboring countries. The average density of population per square mile in 1941 was 72, one of the lowest densities in Southeast Asia. As the economy emerges from its present under-developed status, larger and larger proportions of labor will be drawn from the relatively unproductive bearer-type occupations into more remunerative industrial and mechanized work. By this process an expanding consumer market based on expanding consumer income rather than on expanding population is created. In such an expanding economy, new methods of production and new capital equipment initially replace rather than augment existing methods and productive capacity, and consequently their introduction is far easier to realize than in an economy where introduction of the new involves painful displacement of the old. Too rapid an increase in population will, however, counteract the expansion of production and prevent the rise of the standard of living which is the basic purpose of the development program.

2. LOCATION

Plate 3 shows the population of Burma by districts and the density of population in each district in 1941. The horse-shoe of hills and mountains separating Burma from her neighbors is very sparsely inhabited, the densities ranging from around 50 down to 9 persons per square mile. The bulk of the population is located between the Arakan Yomas and Chin Hills on the west and the Shan Hills on the east, from Rangoon north to Shwebo. There is a high concentration of population in the agricultural heartland—in the delta and north along the Irrawaddy to the latitude of Mandalay—and small concentrations around Akyab and Moulmein. Densities in the main delta districts varied in 1941 from about 40 to 260 persons per square mile. They were similarly high in a few districts around Mandalay and in Akyab District. They are no doubt higher now.

Within this region and even more so in the rest of Burma, the population is overwhelmingly rural, scattered in small villages interspersed with towns of a few thousand inhabitants each. In 1931, 87% of all towns and village tracts in Burma had populations of less than 1,000 and accounted for over two fifths of the total population; 97% had populations of less than 2,000 and accounted for about three fourths of the total population. Since then, there has been a migration into the larger towns due largely to the quest for security from insurgency and dacoity.

Results of the 1953 census operations can be compared to those of 1941 only for 28 larger district headquarters towns of which about the 14 largest are the most populous towns in Burma. These data as well as the 1931 figures are shown in Table I-12. The total increase in population of these 28 towns between 1931 and 1953 was 61%; between 1941 and 1953, they showed an increase of 37%; from 1931 to 1941 their increase was 18%. Immigration into towns for security purposes has been of some significance. Since these 28 towns are district headquarters, as well as being among the largest in Burma, they are the most secure. For this reason they have no doubt experienced the largest increases.


MINISTRY OF NATIONAL PLANNING
DENSITY & POPULATION BY DISTRICTS 1941
KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON
DR. BY. CK. BY. DATE MAY. 1953. PLATE NO. 3
SCALE IN MILES
50 0 50 100
Diameters of Circles are proportional to population of Districts.
1/8" or .125 equals 34,000 persons.
REFERENCES
PROVINCE
DIVISION
DISTRICT
TOWNS
LEGEND
Average Population Per Square Miles Shown In The Circles:—
180 Persons And Above
140 Persons And Above But Below 180
100 Persons And Above But Below 140
60 Persons And Above But Below 100
Below 60
92°
94°
96°
98°
100°
28°
26°
24°
22°
20°
15°
14°
13°
12°
11°
10°
99°
ASSAM (INDIA)
BENGAL (PAKISTAN)
YUNNAN (CHINA)
INDO-CHINA
THAILAND
BAY OF BENGAL
ANDAMAN SEA
GULF OF SIAM
KACHIN STATES
NAGA HILLS
PUTAO
MYITKYINA
KATHA
BHAMO
UPPER CHINDWIN
MAWLAIK
SHWEBO
87
FALAN
HAKA
CHIN HILL
LASHIO
NO. SHAN STATES
LOWER CHINDWIN
MONYWA
MANDALAY
194
SAGAING
207
KYAUKSE
SPECIAL DIVISION OF THE CHINS
ARAKAN HILL TRACTS
PALETWA
11
PAKOKKU
MYINGYAN
199
MEIKTILA
LOI MWE
EA. SHAN STATES
TAUNGGYI
SO. SHAN STATES
AKYAB
94
MINBU
MAGWE
YAMETHIN
KYAUKPYU
THAYETMYO
64
LOIKAW
KAYAH STATE
16
74
TOUNGOO
PROME
SANDOWAY
THARRAWADDY
213
HENZADA
PEGU
PAPUN
SALWEEN
22
248
204
INSEIN
THATON
BASSEIN
MAUBIN
RANGOON
MYAUNGMYA
HANTHAWADDY
239
5892
PYAPON
MOULMEIN
AMHERST
60
YE
TAVOY
MERGUI

The total increase from 1931 to 1953 for 49 other towns for which a comparison could be made, and which were smaller on the average, was 53%; the increase for the rest of the country was probably between 25% and 30%. Except for Rangoon, the large percentage changes in town populations indicated apply to small numerical bases, and the movement of rural population to those towns is not as large as the percentage differences might lead one to believe. Thus, the total increase in population from 1941 to 1953 in the 28 towns is only some 450,000, of which almost one half is attributable to Rangoon; the increase in the population of the rest of Burma was probably in excess of 1,500,000.

3. RACE

There are probably considerably less than a million Indians and Pakistanis in Burma now—perhaps as few as three quarters of a million. In view of immigration policies and of the large number of unmarried persons in this group, their numbers will not increase as rapidly as the national average but may tend to remain constant. About a quarter of a million Chinese represent the only other large non-indigenous race. There are some indications that immigration of Chinese has accelerated in the postwar period. There is a very high concentration of non-Burman races in towns. This increases their proportion to Burmans in the towns and decreases the proportion in the countryside. Many of the non-indigenous population have become or are becoming citizens; the number of non-nationals is much lower than of non-Burman races.

TABLE I – 12

POPULATIONS OF 28 LARGER DISTRICT HEAD-QUARTERS TOWNS, 1931, 1941, 1953*

Towns	*1931*	*1941*	*1953*	*Per cent Increase 1931 to 1941*	*Per cent Increase 1941 to 1953*
1. Rangoon	398,967	500,800	711,520	25·5	42·1
2. Mandalay	147,932	163,243	182,367	10·4	11·7
3. Moulmein	65,506	71,181	101,720	8·7	39·6
4. Bassein	45,662	50,277	77,382	10·1	53·9
5. Akyab	38,094	48,492	41,589	27·3	−14·2
6. Tavoy	29,018	32,964	40,066	13·6	21·5
7. Henzada	28,542	31,114	60,666	9·0	95·0
8. Prome	28,295	31,144	36,762	10·1	18·0
9. Insein	20,487	27,491	28,672	34·2	4·3
10. Myingyan	25,457	26,895	36,439	5·6	35·5
11. Pegu	21,712	26,234	45,941	20·8	75·1
12. Toungoo	23,223	25,960	31,180	11·8	20·1
13. Pakokku	23,115	23,558	29,824	1·9	26·6
14. Mergui	20,405	23,074	33,587	13·1	45·6
15. Thaton	16,851	18,820	37,981	11·7	101·8
16. Pyapon	12,338	15,501	19,180	25·6	23·7
17. Sagaing	14,127	13,631	15,382	−3·5	12·8
18. Shwebo	11,286	13,590	17,827	20·4	31·2
19. Monywa	10,800	13,414	26,279	24·2	95·9
20. Meiktila	9,195	12,321	19,474	34·0	58·5
21. Thayetmyo	9,279	11,847	11,679	27·7	−1·4
22. Yamethin	9,291	10,126	11,167	9·0	10·3
23. Myaungmya	7,773	10,066	24,252	29·5	140·9
24. Maubin	8,897	9,637	23,442	8·3	143·2
25. Magwe	8,209	9,353	12,229	13·9	30·7
26. Tharawaddy	7,131	8,326	7,637	16·8	−8·3
27. Kyaukse	7,353	8,117	8,668	10·4	6·8
28. Minbu	6,005	6,404	9,093	6·6	42·0
Total	1,054,950	1,243,580	1,702,005	17·9	36·7

*According to the complete data of the 1931 census, the first 14 towns were the largest towns in Burma at that time. The others ranked from 16th to 68th in size.

For various reasons, the percentage of foreigners who are in the labor force is greater than the percentage of native people. However, it is highly unlikely that the total number of workers of all non-indigenous races is more than 750,000. Occupationally, indigenous races have retained dominance in the traditional types of work. They virtually monopolize agriculture and constitute over two thirds of the craftsmen. Under colonial rule they lagged in the tasks of modern industry and modern government. Nevertheless, before the war they constituted at least one half of each of the major groups of workers other than agriculturists and craftsmen: unskilled and semi-skilled laborers, traders and shop assistants, clerical workers, and the military and police establishments. However, individual occupations such as that of sweepers were dominated by foreigners. While Burmans did not participate proportionately to their numbers in some of the more stimulating and rewarding occupations of a modern economy, the same is true for some of the least pleasant and least remunerative occupations. The most serious experience handicap is that top managerial-administrative posts in industry and trade before the war were reserved almost completely for foreigners; few Burmans gained the opportunity to exercise those talents which are so indispensable to economic progress, and whose cultivation is an important challenge facing Burma in her development program.

4. SKILLS

It is difficult to describe the skills of Burma's inhabitants in quantitative terms. A rather indirect clue is provided by an analysis of the labor force according to the types of industries in which work is performed. This information is obtained by the census on a countryside basis, and the Labor Directorate is developing a monthly tabulation of the number of workers in selected industries.

Since because of depression, war, and insurrection there has been relatively little "upgrading" of

Burmese industry, the over-all results of the 1931 census are informative. These show that 70% of the labor force was employed in agriculture and related work, 10% each in the classifications of "industry" and "trade," and the remainder scattered in the minerals, petroleum, transport, professional, public administration, and domestic service sectors of the economy. In "industry," most workers were occupied in home and small-scale production of textiles, mats and various handicraft products which do not constitute industrial production in the usual sense of the word. Trade in foodstuffs dominated the trade sector, a large part of which was of the road-side stall and hawking variety.

The latest tabulations of the Directorate of Labor, January to June 1951, which are incomplete, apply to about 700 larger establishments in industry, mining, petroleum, transport, finance and motion pictures. About 55,000 permanent workers are accounted for and these are highly concentrated in transport and allied work (50%) and in the rice-milling, petroleum and saw-milling industries (30%). Temporary workers were even more concentrated in these few industries.

These data are evidence of the well-known fact that Burma has been primarily a land of farmers, small traders and craftsmen. Only a moderately developed transportation system and a few organized industries for processing raw materials exist. These sectors employ relatively old and non-complex techniques and equipment. The same is true for the traditional sectors of the economy such as agriculture, where present techniques, although sometimes requiring a high order of skill, are not highly productive.

5. WOMEN

The industrial potential of women workers as a group constitutes a particularly under-developed national resource. In 1931, about one half of the population was female, and about one third of the women were in the labor force. Since these proportions have probably not changed radically, the present number of female workers may be estimated at about three million. According to the 1931 census, which is probably still representative, about two thirds of the female workers were in agriculture where they constituted a fourth of the total workers. Most of the rest were in trade and industry. Because of the large number of women engaged in all sorts of petty trading, especially foodstuffs, they constituted half of the total workers in trade. In industry also, they formed half of the total by virtue of their near monopoly of spinning and weaving. This latter is by far the main "industrial" occupation of women, followed by work in the food and tobacco industries and in the making of lacquer, baskets and other light hand products.

Because they work in industries of relatively low productivity, because within these industries they occupy the more poorly paid jobs, and because much of their work is seasonal, contribution of women to the national output and their share of total income is considerably less than in proportion to the number participating. There is a large potential for increasing national output by utilizing womanpower more effectively.

CHAPTER II

THE TASK AHEAD

A. ECONOMIC PROBLEM AND OPPORTUNITY

Burma has won her crown of independence; she is striving to adorn it with the jewels of expanded output and improved levels of living and welfare. Her determined effort is part of a tremendous upsurge in the Far East which has been rising for several generations and reached a crest in World War II. Asian peoples without political independence are striving to achieve it; all are seeking economic independence and security as well. In some cases, the obstacles to political independence and sovereignty are well-nigh insuperable. In others, the difficulties encountered in the attempt to achieve economic well-being and security are equally difficult to surmount. In both respects, Burma is exceedingly fortunate. Her political sovereignty is well-established and unquestioned. Her magnificent resources offer her a unique opportunity to achieve, along with economic independence, levels of living and welfare hitherto unknown in Southeast Asia.

The problems which confront Burma in exploiting her potentialities cannot be overlooked. The heritage of the past weighs heavily.

1. THE PROBLEM

Throughout her history, Burma's geographic position isolated her from the changing modes and advancing techniques elsewhere. Like her neighbors, she was half-way round the world from the ferment of technological advance brewing in western lands. In addition, her mountain-locked land frontier and her withdrawn ocean boundary cut her off from the main streams of commerce among her neighbors and between them and the rest of the world. In these circumstances, semi-feudal organization persisted late in her history; the full territorial organization which is a requisite of government and society for advance in productive technology developed only recently. Nature was kind and bountiful, so that the wherewithal of living could be lifted rather than wrested from the soil. Needs for shelter and clothing were few and easily satisfied with but a modicum of work. These factors tended to lessen rather than stimulate the urge for technological advance.

The British colonial administration brought law and order; developed transport and communications; and encouraged investment and increased output in the extractive industries, notably in rice, oil, metallic minerals and timber. These were important contributions. However, the British administration was ill-suited to full economic development. Profits were in large part paid out in dividends or invested abroad, not ploughed back into the Burmese economy, except in the industries producing directly for export. Capital formation under western auspices has in any case existed for only four generations, a far shorter period than that during which capital formation has been proceeding in western Europe.

Most top managers for foreign productive enterprises in Burma were brought in from Europe. In second-level management and technical functions, Indians and Chinese from seacoast trading centers were given experience; Burmans almost none. Indian coolies willing and eager to work for wages too low to support the Burmese standard of living rushed into Burma. Their availability lessened the incentive to introduce technically advanced methods. In agriculture, recognizing a great need, the Government encouraged cooperative societies, and when, mismanaged through inexperience, they failed, the Government assumed the liabilities of the central cooperative banks. But political principles of *laissez faire* prevented the Government from going further to establish an adequate credit system, or from setting up the organization necessary to inculcate improved methods of cultivation in Burma's basic industry.

Thus Burmans entered independence with age-old technologies in most industries, and with truly modern technology in very few; without technical or managerial "know-how" or attitudes; and above all lacking the concept and practice of continuous technological advance. This concept, rather than merely mechanization or the accumulation of physical capital, is the basis of the high and advancing living standards in the industrialized countries of the world.

World War II brought large-scale destruction and ruin to much of Burma's productive plant, and prevented necessary maintenance of that capital which was not damaged or destroyed. With independence came the wholesale evacuation of virtually the entire managerial, technical, and administrative population. And when, despite this serious loss, Burma made a substantial economic recovery in the early postwar years, civil insurrection liquidated these gains and laid the economy prostrate.

The destruction of capital in war and insurrection has been discussed in Chapter I. Output experienced comparable disruption. The output of the entire economy in 1949–50 was 41% below that before the war. In the basic rice industry, acreage was down by one fourth, production by one third, and exports by almost two thirds. Timber exports were only 8% of prewar; metals and ores 5%; and exports of oil, which before the war were one fourth of total exports in value, had ceased. Further to add to the problem, known reserves of metallic minerals and oil have been depleted to such an extent that extraction at the prewar rate will no longer be economic unless new deposits are discovered (see Chapter XXI). The fact that Burma, in spite of these repeated blows, has been able to rally as she has, increasing the total output of goods and services by one third in three short years from 1949–50 to 1952–53, is the strongest possible indication of her ability to meet the challenge of the future.

In spite of this remarkable gain, production, income and levels of living in Burma today are far below the prewar level. The total output of goods and services in Burma in 1952–53 will be approximately K4,297 million or 20% less than the K5,338 million of 1938–39 (both measured in 1950–51 prices). Moreover, because of population growth during the period, output per capita today compares far less favorably with prewar than does total output. In 1952–53, output per capita will be approximately one third below that of 1938–39. These figures are reflected in the current levels of living of the Burmese people—in the food they eat, in the clothes they wear, in their housing in their educational and medical services, in every aspect of everyday life. This is the situation which Burma's plan for economic development must overcome.

2. THE OPPORTUNITY

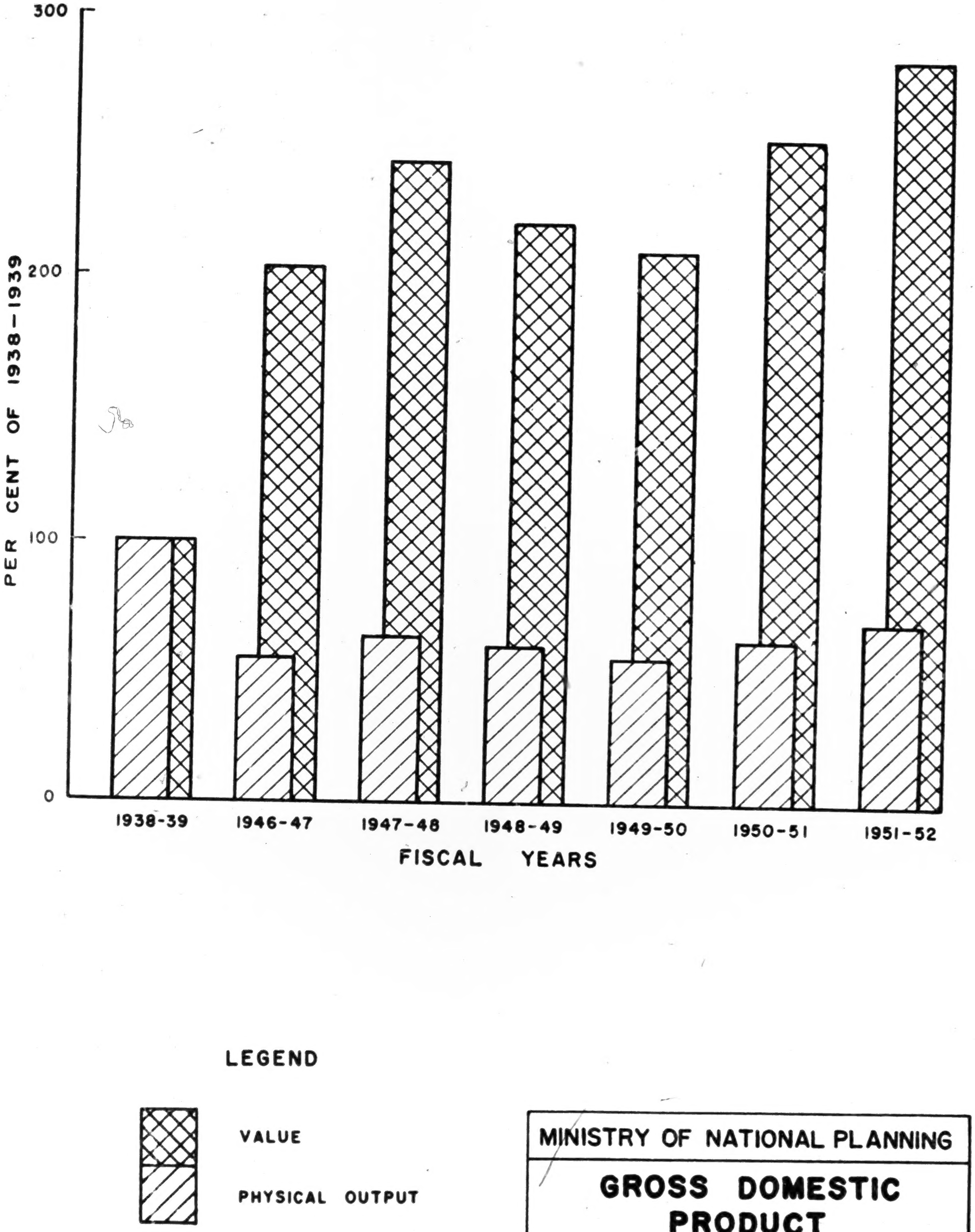
If the problems which face Burma are great, her opportunities for overcoming them are even greater. Her natural resources (described in Chapter I) are enviably abundant. Fertile lands, rich mines and forests, excellent ports and waterways, water resources ample for irrigation and electric power—all these in abundance in relation to the population they must support—can contribute richly to Burma's future. Burma's workers have demonstrated that they have the intelligence and the aptitude to learn the skills and the techniques necessary to efficient production. Burma's financial situation is sound. While her capital equipment is seriously deficient, she has and will continue to have the means to buy the improved equipment she needs. In this respect she is uniquely favored, and will continue to be, for some years at least, in the existence of a highly advantageous world market price for her chief export crop, rice. In combination, these factors provide Burma with an opportunity given perhaps to no other sizable undeveloped country in our time. Will Burma, this golden land, take full advantage of this golden opportunity? The chief objective of the plan for economic development presented in this Report is to assist Burma to make the very most of it.

Wherein exactly lies this opportunity? Certainly it does not lie in the opportunity to produce more and more "things" merely for the sake of producing them. The objective of the economic development plan must be to enable the Burmese people to live longer, healthier, happier lives; to provide more of the good things of life—cultural and spiritual, as well as material—for themselves and their children; and to insure that these benefits will be lasting, and available in increasing measure, for their children's children. How can this be achieved? How can the cultivator be assured of a more certain tenure on his land; easier credit; cheap fertilizer and improved seeds; healthier and more productive livestock; greater output and income; better school and health facilities for his children; sanitary water and electric power in his home; better roads and transport facilities to take him to the village or the market place; sufficient income to buy the many things he needs? How can the worker in the town be assured of a better and more productive job; better pay; more sanitary and safer work surroundings; better housing; improved opportunities for health, recreation and leisure? How can there be assured to every individual the economic freedom that makes reality of his equal right and opportunity to contribute his creative talents to the advancement of mankind in full and equal competition with his fellow man?

The development plan must provide answers to these questions. It must make possible these improved levels of living, and welfare, and human aspiration for all the people of Burma. In order that the improvements it seeks to effect shall be of a lasting character, it must seek also to effect a balanced development—in which every productive sector (agriculture, forestry, mining, industry and trade) and every geographic region will participate and share.

B. DEVELOPMENT GOALS

The Government of the Union of Burma has accepted specific goals for the development of Burma's productive resources during the remainder of the present decade. Such goals are necessary if the largest possible contributions are to be made to the well-being of the Burmese people in the years immediately ahead. With such goals set, the means for their



MINISTRY OF NATIONAL PLANNING

GROSS DOMESTIC PRODUCT

VALUE AND PHYSICAL OUTPUT

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fulfillment can be elaborated, the appropriate policies formulated, and the activities necessary to assure their fulfillment instituted.

In 1951 a comprehensive evaluation was made of the resources and productive potentials of Burma. The outgrowth of that early examination and review was the Preliminary Report submitted early in 1952, in which it was recommended that Burma should strive for a level of total production of some K7,000 million (in 1950–51 prices) by 1959. This was an ambitious goal, almost 90% above the 1950–51 level, but it was also believed to be feasible. It was based in part on a judgement that K7,500 million of development expenditures necessary to achieve the goal could be financed and disbursed by 1959. During the eighteen months intervening since submission of the Preliminary Report, the feasibility of this goal has been given further and thorough study. Three developments during that period have altered the economic basis underlying the original estimates of feasibility.

(1) The original estimate was based on the assumption that insurgency and internal disorder would be substantially eliminated by the end of 1953. While the restoration of internal security and order have progressed greatly during 1952 and 1953, they are not at the stage assumed in the original estimates.

(2) To accelerate pacification and to meet the KMT menace, defense expenditures have been more than doubled (from 1951–52 to 1952–53), and constitute not far from half of total budget expenditures for both current and capital purposes. These defense expenditures may remain at a high level for a number of years. In the presence of civil disorder, they are among the most productive expenditures which the country could make; but the necessity of devoting large numbers of men and large amounts of material resources to defense diminishes the size of the developmental program which the country can support.

(3) On the other hand, a study of the prospective world supply of and demand for rice gives promise of higher prices and larger earnings from rice exports—available to finance the development program—than had originally been estimated. Prices have already fallen somewhat from their record level of late 1952 and early 1953 and some further fall may occur during coming years, but a continuation of prices much higher in relation to import prices than was true before the war and considerably higher than was assumed in making the original estimate, seems assured.

This favorable development will considerably increase the annual rate of capital plus defense expenditures which the economy can support, and will permit the development program to continue at a high rate in spite of the necessity for a large defense program. Because of it, the considerable increase in defense expenditures does not require any major change in the goal for the development program. However, balancing these several factors, and especially because of the delay in attaining internal security, it seems prudent to defer slightly the target date for reaching the prewar level of output. The fiscal year 1959–60, rather than the calendar year 1959, is therefore used as the target date in this Report.

While the goal is expressed in material terms, there is full appreciation of the cultural, spiritual and moral objectives associated with the basic wants and needs of the people. The first expression of the development goal is in terms of physical production, measured for simplicity's sake in money terms, but the basic objective relates to the education and health, the security of shelter and clothing, and the fulfillment of other wants generally comprehended in the expression "standard of living." As physical wants are satisfied, opportunities for creative self expression will multiply, Burmese culture, letters and science will add their contribution to the progress of civilization, the people of Burma will enjoy a more satisfying and more abundant life.

1. THE GOAL IN TERMS OF OUTPUT AND CONSUMPTION

The major goal for the increase in the total output of goods and services in Burma is accompanied by other goals relating to per capita output and to total and per capita consumption. These are shown by Table II-1, in relation to comparable figures for 1938–39 and recent years.

TABLE II – 1

SELECTED GOALS AND COMPARISONS

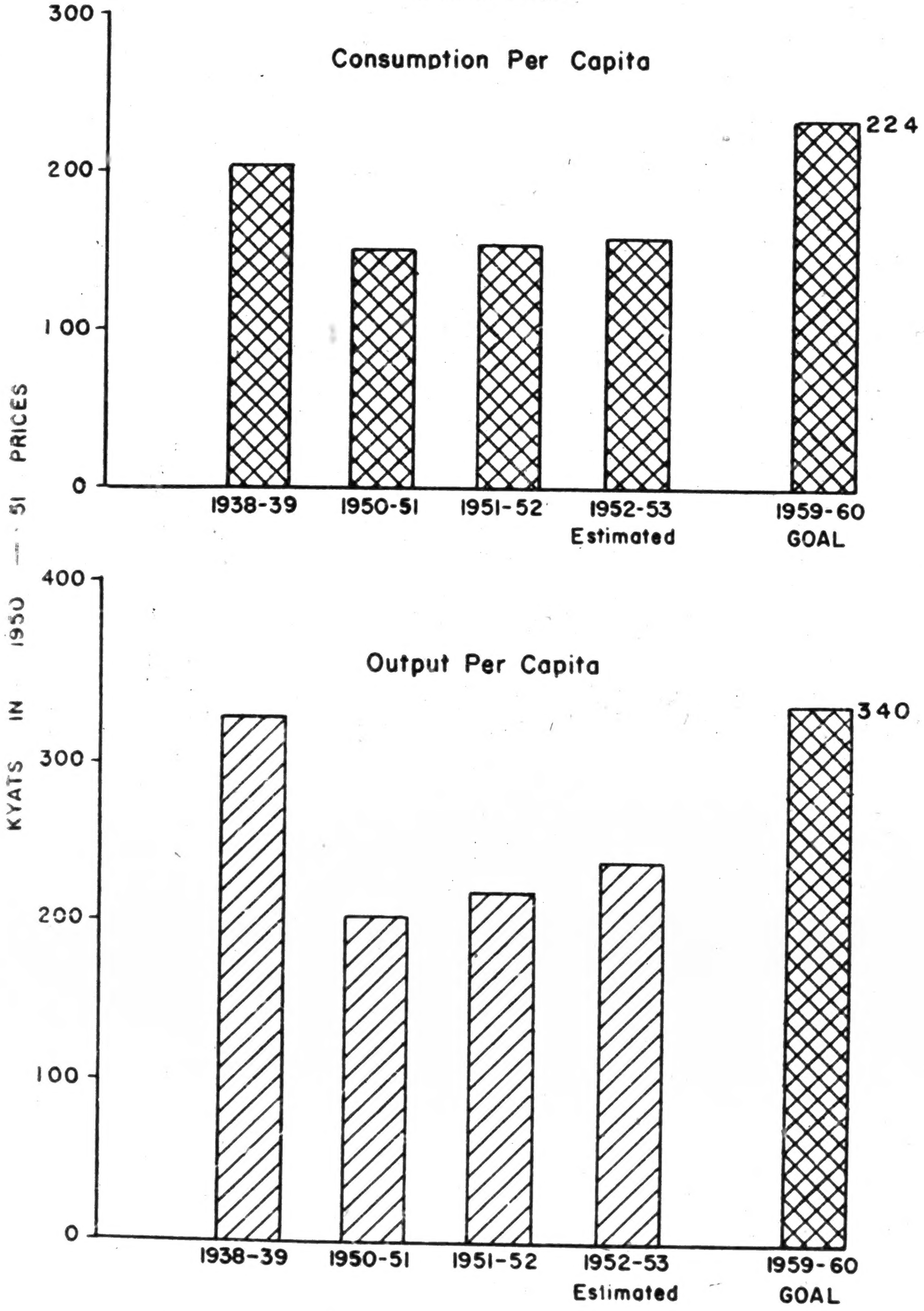
(1950–51 prices)

	1938–39	*1950–51*	*1951–52*	*1952–53*	*1959–60*
Gross Domestic Product					
Total (million K)	5,337	3,710	3,927	4,295	7,000
Per Capita	326	201	210	226	340
Consumer Purchases					
Total (million K)	3,382	2,693	2,745	2,964	4,663
Per Capita	206	146	147	156	224

Achievement of the total production goal of K7,000 million by 1959–60 will require an increase of 88% over the level of 1950–51 and of 63% over the estimated 1952–53 level. It will represent an increase of 31% over prewar.

Achievement of the per capita output goal of K340 in 1959–60 will require an increase of 69% over

FALL AND RECOVERY IN LIVING STANDARDS



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FALL AND RECOVERY IN LIVING STANDARDS

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1950–51 and of 50% over estimated per capita output this year. It will represent, however, only a 4% increase over prewar per capita output.

Achievement of the total consumption goal of K4,663 million by 1959–60 will require an increase of 74% over 1950–51 and of 58% over that estimated for 1952–53. It will represent an increase of almost 38% over prewar.

Achievement of the per capita consumption goal of K224 by 1959–60 will require an increase of 54% over 1950–51 and of 44% over that estimated for 1952–53. It will represent an increase of about 8·5% over prewar.

A few observations will make clearer the significance of these goals:

(**a**) It will be noted that the planned increase in total output and in total consumption above the prewar level are considerably greater than are the planned increases in per capita output and consumption. This is because Burma's population has grown considerably since before the War, and will continue to grow. Hence Burma must increase output and consumption commensurately with population growth just to maintain per capita output and consumption. Per capita output and consumption can increase only to the degree that increase in total output and in consumption exceed population growth.

(**b**) Though the goals set seem extremely ambitious in relation to the levels of recent years, they are more modest when compared with Burma's achievement prewar.

(**c**) The remarkable increase in output achieved since 1950–51 testifies to the resiliency of the economy, and is strong evidence that the goals can be achieved.

(**d**) In 1959–60, with output per capita only 4% above prewar, consumption per capita will be above prewar by 8·5%. This is because a larger share of income will go to consumers in Burma and a larger share of output will therefore be purchased by consumers. Before the war, a considerable percentage of income flowed to foreign firms as profits, as is evidenced by the fact that in addition to the large sums invested abroad annually, primarily by foreign firms operating in Burma, a significant share of the gross national income (in 1938–39, 6%) was paid as dividends or interest to foreign owners of companies operating in Burma. With the nationalization of many large enterprises, it is estimated that a smaller share of the nation's income will be retained as profits and a larger share will flow to consumers.

It may be that the social welfare program will have proceeded far enough in 1959–60 so that a heavier share of income than now estimated is taken by the Government in taxes and used to provide social services such as education and health instead of being left to the individual. If so, private expenditures for consumption may be less than shown in Table II–1, social services to consumers having replaced them.

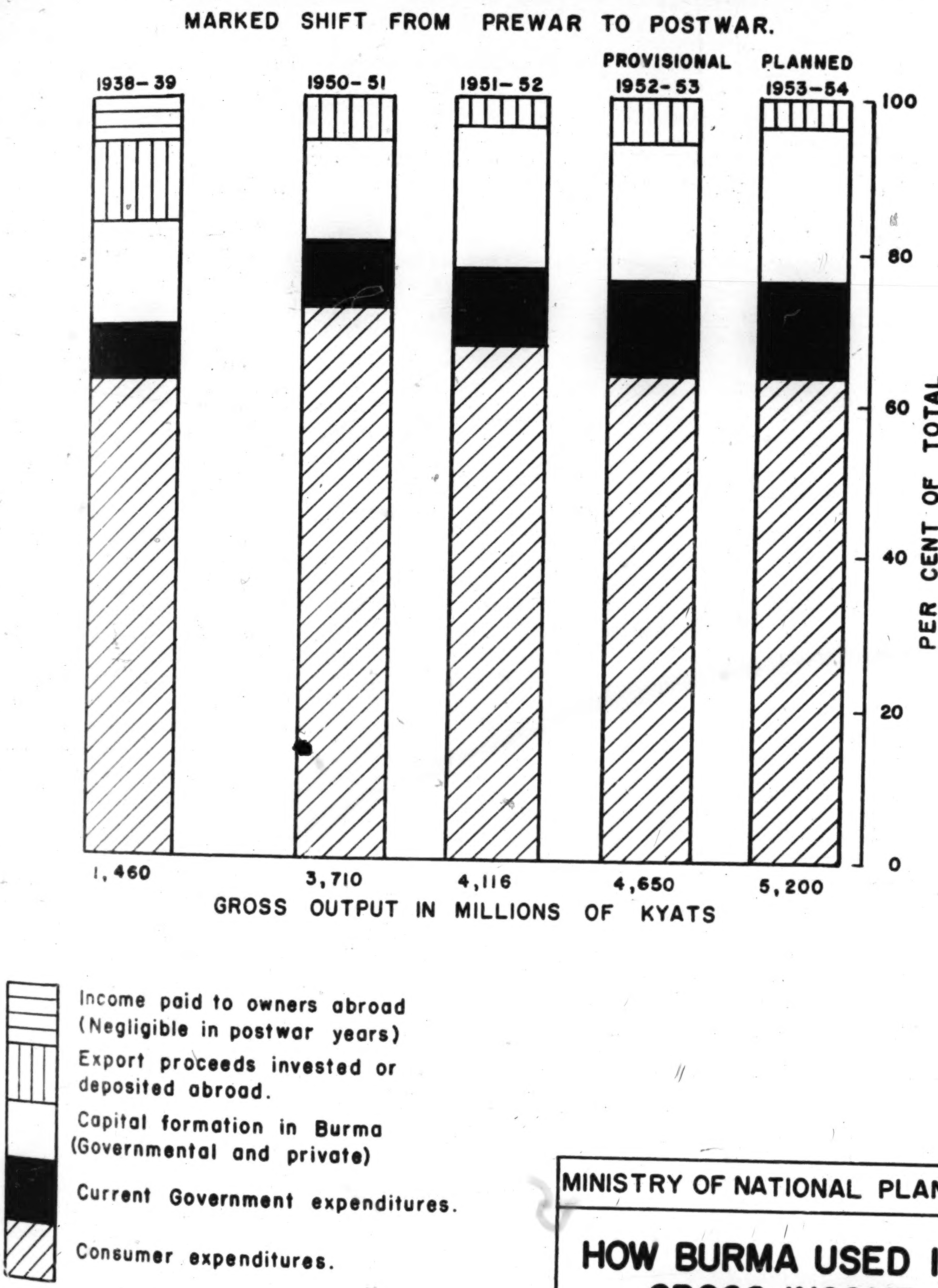
(**e**) In interpreting the 1959–60 consumption goal, less than 10% above the prewar figure, it must be remembered that this is an average increase, and that averages conceal a number of internal differences. Because of new progressive tax measures and because of new social services provided without charge to the mass of the people by the Government, the distribution of income and of economic benefits will be more equal than before the war. If these policies are effectively carried out, classes and individuals who had far larger than average incomes before the war will not enjoy the increases shown; lower income classes will enjoy a somewhat larger percentage increase.

There are limits, however, to the benefits which can be achieved through such redistribution of income. The degree to which redistribution of income can advantageously be effected is limited. The prospect of increasing one's income is a powerful incentive to investment and to efficient production, and if progressive taxation is so heavy that it makes it difficult for the owner of an enterprise to increase his income after taxes, or if other measures reduce too greatly his incentives, private investment will dwindle, production will be less efficient, prices will be higher, and the mass of the people will suffer.

However, the most absolute limitation on the redistribution of income as a method of raising the standard of living is that it cannot bring about an increase sufficient to make a significant contribution to living levels in general. If the entire income of the wealthy in Burma were taken in taxes and distributed in government services or in cash among the nineteen million people of Burma, the increase in income per person would be very small. The wealthy are few and the poor are many. Burma simply does not produce enough goods to yield a high income. Maximum production of which Burma is capable with present methods of production cannot yield a high level of living, no matter how equitably the income from it is distributed. The benefits from optimum distribution of income will be small compared to those from a comprehensive development program.

2. THE PROGRAM FOR ATTAINING THE GOALS

Why were these goals selected? Why is per capita output just above the prewar level deemed feasible by 1959–60, rather than 1964–65? Or why not achieve it by 1956–57? The answer is that attaining the necessary productive capacity will involve large developmental projects. These projects will involve



MINISTRY OF NATIONAL PLANNING

HOW BURMA USED ITS GROSS INCOME

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heavy purchases of materials and equipment abroad, employment of large amounts of labor and natural resources at home, and great managerial and technical ability. It is believed feasible to carry out the necessary expenditures by the end of this decade, but impossible to do so in a shorter period. The program set forth is not an easy one, but it is believed to be a possible one. The availability of the necessary foreign exchange and the necessary quantity of domestic resources is discussed in Chapter III. The availability of managerial and technical skills is discussed in Chapter VII.

These developmental expenditures will include primarily expenditures for addition to the nation's stock of physical capital; its buildings, equipment, tools, and man-made improvements in natural resources. They will also include expenditures for research and for education and training in skills and techniques—especially for expanded professional, technical and vocational education and for a greatly enlarged agricultural extension program. Other chapters of this Report stress the importance of these activities. It would be a serious error to plan a development program primarily in terms of added capital, without adequate provision for these corollary actions which provide the technical, scientific, and educational climate without which an industrial society cannot successfully flourish. To economize on expenditures such as those for agricultural extension or for vocational and technical education in order to free more funds for capital development projects would be pya-wise and kyat-foolish.

The development program recommended in this Report includes both specific projects and a broad program in all sectors of the economic system. During the period of its development program Burma must improve and augment its capital equipment and its methods in many fields. Key projects in the fields of transport, communications, power, irrigation, mining, industry, fishing and forestry are discussed in this report. Those recommended will cost a total of about K3,000 million (see Chapter XXV).

No one should suppose, however, that these planned productive projects can or should constitute the whole of Burma's development program. Partly as a result of the key projects, partly as a result of the steady improvement in security and order, and partly as a result of the stimulus provided by a general rise in national income and in the market for products of all kinds, individuals and firms will also carry out on their own initiative from month to month and year to year many, many projects of repair, rehabilitation and expansion of both old and new productive ventures in almost every field of production, trade and services. The rise in income will create increased purchases and demands for new types of goods which will stimulate investment in a great variety of fields and projects. As national income rises and security improves, individuals will also increase their expenditures for housing and for related improved living facilities. Improvement in transport and communication facilities, included among the key projects, will permit and stimulate many new productive ventures. Development of hydroelectric and other power sources will foster the development of new cottage industries and manufacturing industries. In these and many similar ways, the key programs recommended here will evoke and be complemented by a great variety of capital expenditures by individuals, firms and the Government.

The projects and efforts involved in the entire development program may be classed for convenience into four groups: productive projects planned by the central Government (but not necessarily executed in every case by the Government); other productive projects; and social projects—houses, schools, health and medical facilities, water supply systems and other community facilities—which may likewise be subdivided into those centrally planned and others. The individual projects discussed in this Report belong with the first group. Most of the expenditures for these planned productive projects will be governmental; some will no doubt be private. The variety of other projects referred to will be planned by the person or persons concerned, but will be unplanned in the sense that they will not be individually identified in a central master plan. They will be typically smaller than the planned projects, but in the aggregate they will provide a large share of the increase in the country's productive capacity and output. A development program which ignored them, or failed to establish conditions favorable to their execution, would be incomplete and unbalanced.

Social capital projects will also be both planned and unplanned. The Government's housing program will provide only a small fraction of the needs of Burma's growing population for replacements of and additions to present housing. Unplanned private construction (controlled in the main however by the community planning of individual communities) will provide much the greater share of the nation's new housing. In the other fields of social capital, planned governmental ventures will predominate.

The Government's plans for the economic development of Burma must take into account not only its own planned expenditures for productive and social capital, but also the prospective expenditures of individuals and firms which Government policies will do much to stimulate or retard. The amount of capital formation by Government which will be necessary to reach a given goal for the nation can be estimated only if the private capital formation which will aid that goal is taken into account. The total amount of resources which the people and Government of the country in combination will be willing and able to divert from current use for developmental purposes is limited, and the capacity of the country to support any one of the four groups of developmental expenditures must be gauged in the light of its total developmental program. No one class of projects can be taken as an absolute requirement, before which the other categories must give way. Each class of projects must be considered in relation to the others, and total developmental expenditures must be considered in relation to total national income, to uses of income for current purposes, and to the nation's foreign exchange resources.

Burma's capital needs are reduced by the fact that her rich agricultural, mining, and timber resources will yield returns with relatively small capital investment; a country with poorer resources would have to employ a greater quantity of capital to gain a given return. Her capital needs are also lessened by the absence of population pressure; an over-populated country requires far more social capital relative to its total production and income. On the other hand, Burma requires large expenditures for transport and communication facilities to bind together the long country cut by ranges of hills. One aspect is of especial importance: in agriculture and some other fields it is possible to rehabilitate the productive equipment and restore prewar productive capacity with far less investment than would be necessary if the land were being opened up or the productive capacity being created for the first time.

In view of these various considerations, it is estimated that total development expenditures required to carry the economic system forward from its position at the beginning of 1952 to an output of K7,000 million by 1959–60 will be K7,500 million. Of this amount, expenditures totaling about K900 million have been carried out in 1952 and thus far in 1953. Expenditures of about K6,600 million remain to be carried out during the seven fiscal years 1953–54 through 1959–60, K940 million per year, or about one sixth of the prospective gross national income during the period, a feasible level, as indicated in Chapter III.

This program includes only the net increase required in the nation's physical capital. Total capital formation will have to be greater to offset the depreciation of existing capital through wear and tear and to obsolescence which goes on year by year. For example, since bamboo and thatch houses have a life of only three to five years, new housing construction equal to one third to one fifth of the total number of such houses is needed simply to keep the nation's supply of housing from decreasing, and is not included in the estimate of the required increase in the nation's capital. The program also does not include expenditures for buildings and capital equipment for the nation's defense forces, except to the extent that they will later be useful for civilian purposes.

The estimate of K7,500 million assumes that the program recommended will be completed by 1959–60. This assumption is one determinant of the size of the program. If Burma were to decide to spread the program recommended here over a longer period of years—completing it by say 1961–62—the same investment would not yield the same standard of living. By 1961–62 a larger amount of developmental expenditure will be needed—for in the intervening two years the population will have increased by more than 500,000 persons, and added capital and added productive opportunities will be required.

A corollary of this fact is that, having attained the goal by 1959–60, Burma will not remain there by standing still. She must add capital and new productive jobs year by year at a rate equal to the population increase, merely to keep the standard of living from falling. To continue to raise the standard of living she must provide capital and improve methods to continue to increase the productivity of workers in existing jobs at the same time that she provides the capital and opportunity for added jobs. Burma's development program, like that of every progressive country, must be a perpetual one. Only the first and most difficult step will be completed by 1960.

The total program for 1953–54 to 1959–60 is presented in Table II-2, broken down into three major fields of investment.

TABLE II – 2

DEVELOPMENT PROGRAM EXPENDITURES
1953–54 to 1959–60
(millions of kyats)

Planned productive projects	3,000
Unplanned productive projects	2,950
Social capital	650
Total	6,600

Planned projects should not be regarded as necessarily governmental projects. In the field of transportation, communication, power, irrigation and mining, the Government itself will no doubt carry out, either alone or possibly in joint ventures, all of the larger and therefore planned projects. In other fields, however, and especially in manufacturing, the Government may choose in a number of cases to encourage and aid private ventures rather than to enter them itself. The tabulation therefore does not give an indication of the precise division between governmental and private expenditures.

This, and the precise allocation of governmental expenditures between productive and social capital will be decided by the Government on grounds which are in part neither engineering nor economic in nature. However, the indicated division of the total program between broad fields suggests the general nature of the aggregate program which will be found advantageous.

The plan for economic development must include not only a plan for the total amount of developmental expenditures but an effective allocation of those expenditures between governmental and private, between planned and unplanned, between productive and social, between industries, within the planned area between individual projects, and between successive time periods. The principles on which such an allocation should be made are clear, though their application is complex. They are discussed in the succeeding paragraphs.

C. ACHIEVING MAXIMUM OUTPUT: GENERAL CONSIDERATION

No nation, except as it receives grants from other nations, can regularly consume more than it produces, for the goods will not be made available. On the other hand, if production increases, with economic policies so managed that all goods find a market, income will increase commensurately and living standards can rise. Because of these facts, Burma's standard of living will depend on Burma's total production. The development program is aimed at increasing Burma's productive capacity in the maximum possible degree.

1. RESTORATION OF NORMAL EMPLOYMENT

The first of the two ways in which this can be done, and the most important immediate task of the development program, is to restore to normal employment those persons now unemployed and the much larger number now underemployed. When a man who has been involuntarily idle or partially idle is again able to resume productive work in agriculture, mining, industry or trade, he earns additional income at the same time that he increases the nation's production. As a result of his added expenditures, the market for goods is expanded. Production, demand, and living standards rise hand in hand.

Two conditions in Burma other than destruction of productive equipment have been obstacles to restoration of the normal level of employment. One is civil disorder. The Government has been acting vigorously and effectively to restore order. Since 1949, as the Government has freed for productive uses areas of the country which were in the hands of insurgents, expanding employment and production have brought an increase of one third in the nation's output and income. But the country is not yet fully secure; in many areas production is still hampered. For the immediate future, completing the full restoration of security and providing the capital needed for immediate renewed employment will continue to be the most important single step in raising the level of welfare in Burma.

A second source of unemployment and underemployment has been the fact that in the crippled economy, aggregate income was too low to stimulate enough purchasing by consumers to keep available workers busy. Throughout Burma, cottage industries have been partially idle because people did not have enough income to buy their products. The remedy for this situation is the development expenditures themselves and the continued reclamation of agricultural lands. As development expenditures and exports rise, the resulting injection of added income into the economy will stimulate activity.

2. INCREASING PRODUCTIVITY

The second way in which income and living standards in Burma can be increased is by increasing the productivity of production. If, through the introduction of better methods into a factory, one hundred workers can turn out more goods than before, they can be paid higher wages, or the products can be sold at a lower price, thus benefiting others. If, through the introduction of improved seeds or improved farming methods, cultivators can obtain increased yields, they will obtain higher incomes and live better. If a new industry is more productive than existing ones, it will produce products at lower cost or yield higher incomes. These are merely simple examples of a general truth. In each case, better methods are the key to greater productivity and higher living standards. In Burma, except in the exploitation of mineral resources, methods have improved little during the past century. The key effort of Burma's development program must be to increase productivity.

Productivity may be increased in three ways. One, the most obvious, is to take up the slack in existing idle productive capacity by raising farm prices. (For example, a rise of 5% in the incomes of two thirds of the people should, in itself, support an increase of production of 10% by the remaining one third of the population.) Another method is to introduce new industries which can produce goods in Burma more cheaply than they can be imported, or in the case of export products, at low enough cost to compete in the world market. The third is improvement in methods of production in existing industries.

It is a common misconception, held in Burma as elsewhere, that the introduction of almost any new industry to manufacture within the country a commodity previously imported makes the commodity available to the people more cheaply and benefits the country. This is erroneous. If a commodity is imported, labor and natural resources must be devoted to producing exports in order to pay for it. If it is produced within Burma, labor and natural resources are still required; they must be devoted to the production of the commodity itself. If the cost of production at home is greater than the overseas cost plus the cost of transportation to Burma, production at home burdens the economy and lowers the standard of living. Only if the cost of production at home is lower is there a benefit.

The contrary impression is inherited, in Burma as elsewhere, from a period when ill-informed rulers tried to insulate their countries from the world. In Burma, as in western Europe, several centuries ago, kings were mercantilists. The germ of truth in the idea that production of as many things as possible within the country is an advantage, lies in the idea that it will save foreign exchange. This is an advantage only to the extent that the product can be made more cheaply locally, but saving foreign exchange is commonly done at the expense of living standards.

The experience of other countries indicates the wisdom of exporting one's specialties and depending on other countries for other products. The eight countries in the world with the highest living standards are the United States, Australia, Canada, Denmark, New Zealand, Sweden, Switzerland and the United Kingdom. Every one of the eight except the United States is notable for its dependence on imports for a large share of its needs. The United States, because of the enormous variety of climate and resources within its borders, produces all but a small percentage of the commodities it needs. But if the United States were divided into eight countries, each with a population slightly greater than that of Burma, the foreign trade of each with the others would be exceedingly great. Like the other countries mentioned, each area of the United States has achieved a high standard of living by depending on other areas for the commodities for whose production it is not best suited.

For Burma, introduction of new industries, especially some manufacturing industries, will contribute to a rise in living standards. Industries introduced should be those for which Burma offers not merely the necessary raw materials but over-all productive advantages, and also a large enough domestic market to make the industry economic; plus the very few industries which can compete in the world market. The rate of their introduction should be limited by the rate at which Burmans can gain technical and managerial training and experience. As income in Burma rises, the domestic market will increase and more industries will become economic; but this is a gradual process. Except gradually and in the long run, new industries can employ only a very small fraction of Burma's workers, can produce only a very small share of the goods Burma needs, and therefore can contribute only a small amount to raising living standards. Introduction of new industries must proceed, but it is not the major road to raising living standards. The major emphasis must be on the improvement of methods in the types of production which now employ the great majority of Burma's workers. Of these the major one is agriculture.

The introduction of new methods must not be thought of as a process of taking care of the matter once-and-for-all-time by the introduction of "modern" methods. "Modern" methods cannot be introduced at one sweep; in many industries they will not be efficient until the literacy of the population and the level of its technical training have been raised and the country has gained experience in a new set of auxiliary or service industries. Further, "modern" methods do not remain modern. The best industrial machines will be outmoded in twenty years; the best present strains of seed and the best agricultural methods will gradually be replaced by better ones. Burma must not adopt methods that are now the most efficient, and then stagnate. She must adopt practices and attitudes and methods of training which will induce her producers to be forever dissatisfied with "the best" and to seek continuing improvements in materials, methods and products.

There is no known limit to possible improvement in materials, methods and products. Improvements in methods go on year by year. The improvements in methods are not all spectacular; many of them are small. The important fact is that they continue. The standard of living increases as a result, year by year and decade by decade. Each generation is better off than the one before. Every man can look forward to the prospect that his children will live better than he did, and his grandchildren better than his children. This must come about in Burma also. Burma must become a progressive nation, so that her people not only live better in 1960, but look forward to continued improvement, without limit.

Initial improvements during the remainder of this decade should be many and varied, pervading almost every industry. In agriculture, they must include some large projects and large changes. Of these the main ones are large irrigation projects and steps toward mechanization. But the program must not be confined to these. The revolution in agricultural methods which is needed in Burma must stress such steps as the introduction of improved varieties of plants, the adoption of seed selection practices, the use of commercial fertilizers, better preparation of seed beds, green manuring and the use of available compost materials where appropriate, the liming of highly acid soils, the use of improved implements, better crop rotation, better soil conservation, more efficient storage practices, a many-sided program of disease, insect and rodent control, and countless other fairly simple steps. Creating the human organization necessary to bring about such changes by practical guidance and demonstration in every village in Burma must be an integral part of Burma's development program.

In other industries also, both large and small changes in methods must take place. To cite a few pertinent examples: in fishing, it may be possible to achieve considerable increase in productivity through the development of a deep-sea fishing industry; in salt making, increases in productivity may require the construction of salterns to replace the primitive methods of evaporation now used. Advances in weaving may involve not merely the introduction of modern factories, but also a large number of small improvements in small-scale production methods. Improvements in construction may involve standardizing millwork such as window frames and doors into a few standard shapes and sizes, and investing in the necessary machinery to produce these standard items on an assembly-line basis.

The installation of improved telecommunications equipment will increase not only the productivity of persons employed in telecommunications, but of those in every industry in Burma who need to communicate locally or between cities by telephone or telegraph. Improvement in the organization of postal service can similarly increase the productivity of everyone in Burma who uses the mails. Improvement in the road system and in railways and river transport will have a similar effect. The time lost by delay in a telephone call or delivery of a letter, or by delay in the transport of goods, reduces productivity and reduces the income which an industry can pay to its workers just as surely as does an inefficient method in a factory or on a farm.

In trade and in the services, productivity may increase not only through improvements in transport and communication but also through simple devices such as the adoption of more systematic stock records so that less labor is involved in handling stocks and more efficient service to the consumer is assured. Among these and all other improvements in productivity, some require much additional capital, some little, and a few none. Increase in productivity in one field may involve expenditure for capital equipment; in another, expenditure for training in new methods. In most, it will require both. There must be no more hesitation to spend money to create human abilities than to invest it in tractors or dams.

Though increasing productivity is the only road to continuing increase in living standards, it will not invariably be welcomed. An age-old fear has haunted the worker who has seen improvements in methods increase output; namely, that less labor will be needed, and that he will become unemployed. If this were truly the typical result of improvements in methods, unemployment should be widespread in all economically progressive countries. In western Europe, workers in some industries turn out five or ten times as much product as did their predecessors a century earlier. The result has been not that four fifths or nine tenths of the labor force is unemployed, but that living standards have risen by five or ten times. Workers not only can produce five to ten times as much; they also have enough income to buy five to ten times as much.

Yet for individual workers technological unemployment may exist. And in a partially stagnant economy, when new investment does not keep pace with the savings available for investment, technological unemployment may develop for many workers and worker groups.

The significant point for Burma is that the development program, if carried forward at an appropriate pace, will eliminate any real possibility of a lack of demand for the services of workers because of technical progress. It is unlikely, in Burma, that the demand for goods will increase less rapidly than will productive capacity. But if at times this should be the case in certain industries, so that unemployment develops, then more workers can be used on development projects. None need ever be idle for long periods for lack of demand for their services.

There may nevertheless be problems of adjustment for individual workers who must shift from one occupation to a new one. The Government should in such cases take steps to aid the transfer of workers to a new occupation, and may properly grant them financial aid during the process. Other forms of aid or unemployment compensation may be devised to insure the individual worker against the hazards of temporary dislocations until he can adjust himself to a new situation. There need be no threat of hardship to the individual worker if adequate social planning accompanies the technological changes. An advance which will raise the standard of living of workers in general should not be barred by temporary inconvenience to the few.

D. CRITERIA FOR THE SELECTION OF PROJECTS

Certain well-defined criteria are tests of whether a project will be advantageous to Burma. They have been applied in formulating the development program. In this section, they are listed and discussed briefly, and the technical and economic interrelations between them are then discussed at greater length.

1. THE CRITERIA

Within the limits of Burmese labor supply, natural resources, and present productive facilities, the following factors have been considered in selecting projects:

(*a*) Suitability of climate, soil, and natural resources.
(*b*) Adequacy of market.
(*c*) Adequacy or potential adequacy of transport.
(*d*) Obtainability of power.
(*e*) Obtainability of skilled labor, technicians and managers.
(*f*) Obtainability of complementary facilities to service complex and technical processes.
(*g*) Economic feasibility of foreign material or equipment purchases.

A few examples of the effects of these criteria may be presented. The more favorable the country's natural resources for any given industry, the better its prospects. Because Burma's climate is so varied, most types of agricultural production can yield high income in some locality in Burma, if the proper methods of production are used. Manufacturing or processing industries for which good raw materials are available at low cost, for example pulp and paper manufacture, will yield greater income per person engaged than ones for which materials cost is high. Other things being equal, low transport and power costs, made possible by favorable transport routes or power sources, have much the same effect as low raw materials costs. The existence of a market in Burma or nearby may be of crucial importance even if some factors relating to production in a given industry are less favorable in Burma than elsewhere.

An otherwise advantageous new industry, or use of new methods in an old industry, may suffer a temporary disadvantage in Burma because skilled and technical labor of the types required are not available. In general, this factor should not be given great weight, since labor can be trained, and indeed must be trained, in new skills if new types of industry are ever to be introduced. If an industry, once established, will be advantageous, temporary inefficiency while the necessary skills are being acquired, or rather while skill is steadily increasing, is a price well worth paying. It would be proper to charge short-run expenses involved in training such workers, technicians, and managers to original investment, rather than to current operating costs. However, the more technical and complex the production process in a given industry, so that a large number of experts with a high degree of professional and scientific education and experience is necessary for efficient production, the more difficult the problem becomes. Burma's own supply of technicians trained in industrial sciences is extremely small; with even the most intense efforts, which should be and are being exerted, it cannot be increased rapidly. The need for such technicians during the next generation will be much greater than Burma can meet; this must be one factor determining the order of priority of the steps in her continuing development. Similar considerations apply to management. The management of a modern productive enterprise is a complex and exacting job, demanding years of experience and a combination of talents possessed by only a few men. Without top quality management, the best designed venture may fail. The availability of management is as necessary as the availability of raw materials or transport or power.

Many modern manufacturing industries depend not only on technical skills within themselves, but upon service or auxiliary functions by other complex industries which have grown up to serve an industrial network over generations. For any technologically complex industry, an important question therefore is the availability or possibility of introducing the necessary auxiliary industries.

The peculiarly fortunate world situation in which Burma finds herself at the time of her great developmental effort makes unnecessary any Spartan abstention from foreign purchases. Burma's present and prospective foreign exchange position is strong, as Chapter III makes clear. There will be no need during the coming decade for her to avoid any project because of the foreign materials required, nor to introduce any new industry solely because it will reduce imports. No industry need be introduced unless it will be sufficiently efficient to help raise the standard of living. It will be desirable when purchasing materials or equipment abroad to give preference to purchases from non-dollar areas, but even this need not be a rigid requirement, as Chapter III indicates.

The selection of projects must of course be based on an engineering and economic study of all of the other criteria. No one factor or its absence is determining; the degree to which every factor is present and the effect of all in combination must be considered. While the criteria are simple, their quantitative evaluation and joint application is often complex.

2. TECHNICAL COMPLEMENTARITY

Moreover, no one project can be properly evaluated in isolation. The development program is greater than the sum of its parts. The contribution which a given project can make to the standard of living in Burma depends not solely upon that project considered by itself, but upon its relationship to the program as a whole. Many advantageous projects must be complemented by other projects. Many projects which would be wasteful if constructed alone are essential and advantageous if other projects which will provide materials, market, power or transport are also developed. For example, the Myingyan refinery project would not be efficient without both the zinc mines and the Kalewa coal development.

Such technical complementarity is especially relevant with respect to transport, communication and power. The country's means of transport are its veins and arteries, through which its life blood flows. The desirability of expenditures on river, rail, road, and air transport is not to be tested merely by the net income, if any, earned by each system, nor by the income which each will pay out to workers and to the State, but by the contribution of the integrated transport system to moving the country's commodities efficiently, expeditiously and economically to their destinations, and thus reducing the costs of production and the costs of goods to consumers. The port of Rangoon, for example, and the country's other ports must be equipped with added facilities by certain dates if the country's foreign trade is to be carried on. It happens that the port of Rangoon is a highly profitable venture (though of inadequate capacity), but investment in new facilities would be needed and desirable if it were not. It may be possible by the end of the decade to establish the operations of the Burma Railways on a profitable basis ; but even if not, the railways are indispensable to the economic life of the country, and their equipment must be rehabilitated, modernized and augmented. The investment recommended in each transport mode during the next seven years is the amount thought necessary to provide efficient and economical transport for the amount and types of production which are anticipated, with due regard for the distances and directions over which they must be moved.

The same is true of communications; postal communication and telecommunications must be and have been planned in a similar integrated way, for similar reasons. In a comparable fashion, power development is justified, not alone by the income created in the power industry, which yields a fairly small return on a large capital investment, but because cheap power is peculiarly important in furnishing opportunity and stimulus for the creation of new efficient industries and for reduction in costs and increase in income in many of the country's existing basic industries. Conversely, power developments are feasible because new power-using industries will provide enough demand for power to make power projects economic. Power projects and the industries using them interlock; each is advantageous because of the other. The planned amount and nature of expenditures on power development, like those on transport and communication, are those needed to create facilities of the right nature and amount to serve the expanding economy.

3. BALANCED ECONOMIC DEVELOPMENT

The need for economic complementarity, which is as essential as technical complementarity, may be stated summarily as follows. Burma's growing labor force will require increasing employment opportunities. Some of these will be provided in agricultural expansion; some must be provided in new industries, which in any event are desirable in themselves. Some will also be provided in the construction activity of the development program itself. To furnish a growing market for new industries, per capita income must increase throughout the economy. This increase can be brought about only by increasing productivity in existing industries. Doing so will release some workers from existing industries. New industries and construction must absorb them. Thus the introduction of new industries and the improvement of productivity in existing industries must proceed hand in hand.

The Burmese economy is an expanding one. The population is increasing at a rate between 1·2% and 1·5% per year, probably at about 1·3%. The labor force is growing at roughly the same rate. Hence the basic need for expanding employment opportunities. Agriculture, the dominant industry, will itself provide some of these opportunities, for unused agricultural land of good quality is available for exploitation. But some of the best opportunities will be outside of agriculture; if the standard of living in the expanding economy is to rise, and to rise at the fastest possible rate, some of the new employment opportunities must be in manufacturing industries which are economic for Burma, but which have not yet been developed in Burma.

In Burma, as in any country, most manufacturing or processing will be for the domestic market, since natural resource advantages which will enable new industries to compete advantageously in the world market are limited. But there are only a limited number of manufactured products which Burma can produce efficiently and for which sufficient demand exists in Burma at present. People with low per capita income, as in Burma, spend almost all of it on basic food, clothing, shelter and the simple necessities of life. A few of these necessities are industrial products, and out of the remaining fraction of their income they also buy a few minor luxuries. The consumers' market for industrial products will be limited for some time to these few expenditures by the masses, plus expenditures by the well-to-do. Since the light consumers' goods industries will be small in scope and volume, they, in turn, will comprise a small market for heavy or basic industries manufacturing producers' goods—machinery parts and equipment, basic raw materials, and others.

Hence only a fairly small number of new industries will be efficient in Burma at present. Unless an increasing domestic market is created, both for consumers' and producers' goods, the process of industrialization must grind to a halt.

The introduction of this limited number of industries will itself raise the average level of income, and so increase the domestic market. But the extent to which industry can feed on itself in this way is limited. The development in Burma of an increasing market for industrial products therefore depends on an increase in per capita income throughout the entire economy. For this increase, agriculture offers the dominant opportunity. Income in agriculture is now low, but the potential exists to increase it substantially. A fundamentally important step in the industrialization of Burma must therefore be a comprehensive, well organized and determined program to achieve a continuing increase in productivity and in the standard of living of Burma's agriculturists.

Such a program is discussed in detail in Chapter VIII, Agriculture. Its results will be to create a steadily increasing margin of income above the subsistence level and a gradual expansion of expenditures not only for a greater quantity and improved variety of food, shelter and clothing, but also for a greater variety and quantity of other products and services. Thus it will make possible and indeed require the expansion of manufacturing industry and of trades and services.

Improvement in productivity in other occupations throughout the economy—cottage industries, mineral and timber extraction, trade and transport, government, and all other—can make a contribution similar in nature but more limited in quantitative importance, in correspondence with the lesser importance of these other occupations in the economy.

Increase in productivity in existing industries, for example agriculture, creates problems and opportunities of its own. As the efficiency of agricultural production increases, each person engaged in agriculture will be able to cultivate a larger area of land and there will be a continuing surplus of workers on the agricultural land now cultivated. Even while there is good agricultural land not yet cultivated, not all of these surplus workers should remain in agriculture, and when the good quality land has been occupied, all of them must find productive employment elsewhere. There must be a constant new demand for workers elsewhere. This increasing demand for workers can be created by a steady expansion of industrial production and of the trades and services which are a part of urban life.

Hence, for maximum prosperity and social stability, the expansion of new industries and services and the increase of productivity in agriculture and other existing occupations must proceed hand in hand. This is the law of balanced economic development. And this is one reason why the present Report recommends both the introduction of new industrial ventures and a program of improvement in methods of production in agriculture and other existing industries.

However, it should not be supposed that if increase in productivity in existing industries and the introduction of new industries are not perfectly synchronized from year to year, there is no escape from increasing underemployment, and some degree of stagnation. Synchronization may often be imperfect. This is merely the problem of technological unemployment, whose remedy has been discussed. The construction activity of the development program itself is a balancing factor. If increase in the labor force or in its productivity makes workers available at a more rapid rate than that at which they are being absorbed in new industries, they will be available for work in the development program, and the pace of that program can be stepped up. Only if the problems of administration and management are not solved will the development program be unable to employ productively all available labor and prevent underemployment. On the other hand if the demands of new industries for workers exceed the number of workers available, the shortage must cause retrenchment either of the development program or elsewhere.

4. THE SOCIAL SERVICES

The discussion of balanced economic development thus far has dealt only with the question of economic complementarity between introduction of new industries and increase in productivity in old. Proper balance in economic development requires allowance for an additional factor, namely the place of expenditures for social welfare services. The activities which have been discussed so far in this chapter are those whose value is measured in the market place. Social welfare activities, even though their benefits cannot be evaluated in financial terms, are an equally important part of a balanced development program. Burma has great need for more and better schools, specifically for vocational and technical training, and more generally for the broader education of her people. She has need for an expanding program of public health activities and of medical care, to care for the bodies of her people even while she cares for their minds and spirits. She has need for better housing. Better health, education and housing increase the productivity of the labor force. Purely from an economic viewpoint, a development program without these components would be warped and incomplete. Their value is of course humanitarian, not merely economic, but this does not really distinguish them from other phases of the development program, for the ultimate purpose of the entire program is to enhance human welfare by raising living standards. The essential difference is that the humanitarian effect of the social welfare services is direct, of other phases of the program, indirect.

Social welfare expenditures must be large enough to permit education, medical and health care, and housing to make their proper contribution to human welfare, but not so large that they choke off other phases of development. In evaluating their proper magnitude, it should be recognized that when the development program has gathered real momentum, shortages of labor and materials will appear. Labor shortages should be balanced as far as possible by progressive mechanization. Thereafter the social welfare programs will compete for materials, men and money with other programs. At this point, the faster the construction of schools and hospitals, and the larger the program to staff them, the slower must be the pace of programs to improve agriculture, to introduce new industries, to develop mines, to build roads and ports and power plants.

The slower the rate of improvement in these productive fields, the lower the rate of increase in per capita income. On the other hand, the faster the improvement in productive methods, the higher the level of income later, and the greater the expenditures which can later be afforded for health, education and housing, among other programs. The balance between social welfare programs and other programs is therefore a balance between immediate social welfare and future social welfare. Neither the claims of the future nor of the present should be neglected. A reasonable balance must be struck.

E. REACHING THE GOAL: PLANNING AND EXECUTION

This chapter has presented a goal for Burma's development, and has indicated the basis on which a plan to reach that goal has been evolved. The plan is presented in this Report. Its presentation is only a small step in Burma's development program. The Government, which has already accepted the basic principles of the plan, must now evaluate it in its full form, prepare its own program for action, and adapt its economic policies where necessary to the program. The job of execution will then lie ahead.

The plan presented here embraces the entire economy, even though it does not present specific projects in all sectors. The Government's planning must be similarly comprehensive. Good planning will provide for the balanced use of resources, through unplanned as well as planned activity, and will seek to enlist the full participation of the entire nation—government agencies, cultivators, workers, traders and industrialists alike, both at the center and throughout the country. There must be a real educational effort to acquaint all concerned with the basic aims, objectives and features of the plan, and to enlist the cooperation of all concerned in both the development and execution of the plan. Good planning must also provide for programming and re-programming from year to year as the past progress in various sectors requires.

Effective execution of the plan will depend in large measure on the kind of widespread cooperation indicated above. It will also depend on effective organization and administration within Government, in the ministries and departments, within the Development Corporation, within public corporations, and throughout the private sectors of the economy as well. It will depend in large measure on how successfully Burma solves the problems of technical skills and management, especially in the early phases of the plan. It will depend in serious measure on the determination, the vigor, and even the daring displayed by those entrusted with responsibility for carrying out the plan.

Carefulness in planning is not inconsistent with daring in execution. Every important consideration should be taken into account in arriving at a decision to incorporate a given feature in a plan of action. Once the plan is formed, the time for action has arrived. Decisions need to be made. Responsibility for making decisions must be accepted and discharged. Action must not be unduly deferred by those responsible because they are fearful of making mistakes. Mistakes will undoubtedly be made in executing the program. However, they will not bulk large in the total picture. By far the most serious mistake of all would be the mistake of doing nothing to avoid all possibility of mistake.

On the basis of the discussion above, it will be plain that at least three and perhaps four problems exist which comprise key bottlenecks to the development program. These must be overcome if the program is to succeed. The first of these is the question of internal security. While a great deal of progress has been made since the preliminary report was submitted toward improving security conditions, a good deal yet remains to be done. Continued rapid progress in security throughout the country and achievement of a reasonably complete state of internal security within another year will be necessary if the economic development program is to proceed at the pace required. The second key bottleneck is that which arises from the acute shortage of skilled technicians and experienced managers and administrators. Indeed, it would not be overstating the case to say that the success of the development program hinges more on this than on any other single factor. The third bottleneck is that which arises in the organization and administration within Government itself, where established modes and procedures are in tune with the more leisurely pace of another day, having developed in response to a relatively static rather than a dynamic way of life in Burma. Organization, administration, and personnel in the government ministries, agencies, departments and boards must be brought into step with the dynamic requirements of the development program. Finally, determination, vigor, and daring must be displayed by those charged with responsibility for the execution of the development program. There has been no opportunity to evaluate as yet the degree to which these qualities will be forthcoming. It is to be hoped that they will be present, for it is clear that the program will falter without them.

Given the abundant resources which nature has bestowed on Burma, the exceptionally strong financial position of the Government both in relation to internal cash balances and external assets in the form of foreign exchange, and the will of the people guided by intelligent and strong leadership, it is not too much to expect that the people of Burma will be able to produce within a few years, on the average, slightly more per capita than they did a generation ago and to go on thereafter to an ever-increasing standard of living. The basic potentialities are here. The great advances which have been made elsewhere in modern technology and in putting machinery to work for the benefit of mankind are available. Burma has the opportunity to telescope within a limited number of years the process of increasing productivity which took generations for other nations to achieve.

Too much emphasis cannot be placed on the fact that material and financial resources alone do not guarantee economic progress. Some countries which have been endowed richly with natural resources suffer low productivity and low standards of living. Fertile land, favorable climate, ample rainfall, rich mineral resources and abundant forests do not necessarily mean high productivity. On the other hand, there are nations whose people have learned how to organize their economic activity and how to exploit their limited resources for their economic well-being. There is no reason why Burma, with its limited population in relation to its geographic area and its natural resources, should not in time enjoy one of the highest standards of living among the nations.

The task is now one of organizing and mobilizing the resources of the country so that its fullest potentialities can be realized. The task can be done provided the will exists—the will to understand as well as to do. Among the leaders of Burma, both inside and outside the Government, there is manifestation of such a will.

The chapters which follow discuss various aspects of the tasks referred to in this chapter. Chapter III discusses the financial feasibility of the plan recommended. Chapter IV considers the central economic policies necessary to carry it out. Chapter V then discusses the necessary organization of the Burmese Government for planning and programming; Chapter VI, organization of execution, and Chapter VII the key problem of manpower and management. Parts III to VII then present sectors of the plan, and Chapter XXV summarizes in time schedule the full program for the planned sector of the economy.

PART II

ECONOMICS AND ADMINISTRATION

CHAPTER III

FINANCING THE PROGRAM

A. THE NATURE OF THE PROBLEM

Table II-2 of Chapter II indicated the capital expenditures recommended for Burma's development, and their distribution among broad fields. The present chapter discusses the problem of financing them or, what is equivalent, the problem of allocating a large enough share of Burma's productive resources to the program to carry it through to completion.

The analysis is based on two assumptions concerning world conditions and conditions in Burma during the remainder of the decade:

(1) That there will be no general war.

(2) That there will be continued rapid improvement in security within Burma.

No rigid assumption is made concerning world economic conditions. Continued world prosperity is not a necessary condition for the successful prosecution of Burma's development program. The depression of the 1930s reduced the prices of Burma's imports as well as of her exports, and improved her balance of trade. It is difficult to say what the net effect of a world depression during the 1950s might be. Certainly it is not necessary to conclude that it would prevent the successful execution of the program. The other two assumed conditions are, however, necessary bases for the successful execution of the program, and its financing is therefore analyzed on the supposition that these conditions will prevail.

1. FINANCING EXPENDITURES AT HOME AND ABROAD

About one third of the development program expenditures will be made abroad, for the purchase of capital equipment and materials, and about two thirds in Burma, for the purchase of indigenous materials and products and the employment of labor.

The problem of financing the purchases abroad differs in nature from that of financing the domestic expenditures. The purely financial aspect of the domestic problem is simple. The necessary kyats can always be obtained by the Government without difficulty. If, however, labor and indigenous materials are scarce, purchasing the materials and employing labor on new projects will cause inflation. The question, therefore, is one of whether enough productive resources, especially labor, will be available. The question is expressed in monetary terms only because money is the convenient common denominator for totaling the needs of all the different projects, the value of resources needed, and other factors.

The question of obtaining foreign currencies for purchase abroad, on the other hand, is essentially a financial one. Burma need not concern herself with the underlying economic question whether her purchases (small in the total world picture) will contribute to scarcities and inflation in the supplying countries. The only questions which need concern her are whether she has or can command enough foreign currency to purchase what she needs, and whether she can find suppliers who will deliver the goods.

The magnitude of each of these two problems will depend on the share of the expenditures which consist of purchases abroad, the time distribution of the expenditures over the seven-year period remaining, and the share of the program which the Government undertakes as compared with the share which is left to private investors.

2. WHY ONE THIRD EXPENDITURES ABROAD?

The share of a country's expenditures for economic development which must consist of purchases abroad depends on the resources and industries of the country. In the United States or in the Soviet Union most of the materials and equipment for developmental projects could be produced within the country. In developing oil fields in desert areas of the Middle East, on the other hand, a very large portion of the expenditures were in other countries; only a small amount of local labor, and food and simple equipment for the construction crews could be furnished within the country.

Burma has ample resources of timber and unspecialized labor, can now produce building materials such as lumber products, cement, lime and low quality brick, and will be able fairly quickly to improve the quality of her brick, and to create added productive capacity for brick, lumber products, lime and tile. It would be much more costly to import these commodities than to make them domestically. She will find it necessary to continue to import many other materials and almost all industrial equipment and heavy metal products.

Experience in other countries suggests that in Burma's circumstances, taking the developmental program as a whole, at least one third of the developmental expenditures will be for materials and equipment purchased abroad, and not more than two thirds for labor in Burma and for materials and equipment which can be produced in Burma. If defense expenditures for "capital" items, including munitions, are included in the calculation, the proportion abroad will be greater, for munitions are necessarily purchased almost entirely abroad. The percentage of purchases abroad shown by the final estimates is 34·6% excluding defense purchases and 36·9% including them.

The ratio of expenditures abroad to those at home will vary from industry to industry, and even more from project to project. For some construction projects which consist largely of earthwork construction or of timber structures, and for other projects which use a relatively large amount of construction labor on the site in comparison with the value of equipment, much more than two thirds of the expenditures will be made at home. At the other extreme, expenditures for expansion of the river and harbor flotillas will be met almost wholly abroad, and those for other projects involving the installation of heavy metal equipment will be met largely abroad. The proportion of about one third abroad to two thirds at home is an average of expenditures for the entire program.

This proportion is neither precise nor inflexible. It will vary to some extent depending on the projects selected and on the materials selected for a given project. While in the main the selection of projects and materials must be determined by other criteria, there will be some freedom to choose between projects or different materials requiring or permitting different proportions of foreign to domestic capital purchases. For example, either teak beams fabricated in Burma or steel spans prefabricated abroad can be used for small bridges. Such choices will, however, be fairly limited. They are one way of conserving labor in Burma, if it is scarce, by spending more money abroad, or of conserving foreign exchange, if it is scarce, by using more labor in Burma.

3. THE TIME SCHEDULE OF DEVELOPMENT EXPENDITURES

The financing problem will also be affected by the timing of development expenditures. If the program gets under way slowly, a correspondingly larger effort must be crowded into the last years of the decade to complete the program within the time planned; if a fairly high level of expenditures is attained soon, the program can be spread more evenly over the remaining years.

Except in one respect, noted below, the time distribution of the program will not materially alter the problem of financing foreign exchange expenditures (expenditures in foreign currencies). Because of increase in her exports, Burma will earn more foreign exchange annually during the later years of the decade than during the years immediately ahead. However, Burma should have sufficient foreign exchange during the next several years to finance purchases abroad for the development program, even if expenditures for the program should rise at the maximum rate which seems possible. If their rise is slower, the foreign exchange earnings will of course accumulate and be available at a later date.

In one way, however, the rate at which the program gets under way will affect the foreign exchange problem to an important degree. The more rapidly complete civil order is restored, and rice, mineral and timber production and exports increase, the larger will be Burma's foreign exchange earnings. The progress of restoration of civil order is therefore of first importance as a determinant of Burma's foreign exchange position.

Rapid progress is even more important to make possible completion of the necessary expenditures within Burma. If a disproportionately large share of the program remains for the last years of the decade, the share of the nation's labor and resources required to carry it out during those years may be too great to be achieved. The more quickly expenditures on the program reach a high rate, the lower will be the amount which must be completed in any one year and the easier the problem.

There is sufficient slack in the economy now to permit a rapid rise in development expenditures. To some extent, the rate of rise in total expenditures will depend upon the degree to which the Government creates an environment favorable to private investment, a problem discussed in the last section of Chapter VI. To an even greater extent, it will depend upon the effectiveness with which the problems of administering the Government's share of the program are met. The major administrative problems will be setting up the necessary organization for effective management, obtaining the necessary managerial talent, technical skills, and specialized labor, and breaking some materials bottlenecks. While in theory the program might rise so rapidly that a peak rate might tax the economy's resources in the near future, the problems of administration are such that there is no likelihood of this occurrence.

Table III–1 indicates a plausible schedule for the entire program—public and private, planned and unplanned, productive and social—during the years 1953–54 to 1959–60. This schedule of expenditures is used as the basis for the discussion of financial requirements which follows. The schedule of planned projects presented in Part VIII fits appropriately into this more comprehensive program. The comprehensive schedule should be regarded as a minimum target, not an ideal pattern. If development expenditures lag significantly behind it, there is danger that the program will not be completed. If they exceed it in the years immediately ahead, the prospects for successful completion of the program are correspondingly enhanced.

TABLE III – 1

DEVELOPMENT PROGRAM EXPENDITURES

Year		*Expenditures (millions of kyats)*
Jan.–Sept., 1952		415
1952–53 (est.)		485
Programmed :	1953–54	655
	1954–55	830
	1955–56	950
	1956–57	1,015
	1957–58	1,030
	1958–59	1,050
	1959–60	1,070
Total, 1952 to 1959–60		7,500
Total, 1953–54 to 1959–60		6,600

The development program includes all capital expenditures for net additions to the country's productive and social capital. It does not include either capital projects for defense purposes or capital formation to make good the depreciation of existing capital which goes on year after year. Table III–2 adds estimates of these elements, and divides the expenditures between those at home and those abroad. There is of course no sure basis for forecasting defense capital expenditures. They are assumed to reach a level of K120 million in 1953–54 and to decline gradually thereafter. Estimates of the amount of capital formation needed to offset depreciation are based on estimates of depreciation during past years on all capital plant and equipment of the economy.*

TABLE III – 2

GROSS CAPITAL EXPENDITURES, 1953–54 TO 1959–60, INCLUDING DEFENSE, DIVIDED BETWEEN AT HOME AND ABROAD

Year	*Total*	*Abroad*	*At Home*	*Per cent Abroad*
		(millions	*of kyats)*	
Jan.–Sept., 1952	625	120	505	20
1952–53 (est.)	835	200	635	24
Programmed:				
1953–54	1,035	442	593	43
1954–55	1,190	503	687	42
1955–56	1,315	531	784	40
1956–57	1,385	527	858	38
1957–58	1,405	500	905	36
1958–59	1,430	454	976	32
1959–60	1,455	445	1,010	31

4. GOVERNMENT VERSUS PRIVATE DEVELOPMENT EXPENDITURES

The third factor which affects the problem of financing the program is the division of the program between government expenditures and private expenditures. All investment in the economy must be matched by saving. The greater the share of the investment which the Government undertakes, the greater the share of current saving which it must in one way or another siphon off to its use. This division of investment between government and private will be important so far as financing within the country is concerned. It will not however affect Burma's ability to meet her foreign exchange needs ; as is shown below, Burma will be able to meet them regardless of the degree to which private investors from abroad invest in Burma. Discussion of the division of investment between government and private is therefore deferred to Section C, dealing with financing expenditures within Burma.

B. FINANCING FOREIGN EXCHANGE PAYMENTS

The financing of purchases of capital equipment and materials abroad during 1953–60 can be accomplished from earnings from exports during the period, from use of foreign exchange previously accumulated in excess of the minimum needed as reserves, and from the flow of foreign capital to Burma. All three are available to Burma. She has accumulated foreign exchange reserves in excess of her requirements and international lending agencies very probably would consider favorably loan applications for certain types of projects. Financing from the proceeds of her exports must, however, be her main reliance.

1. FOREIGN EXCHANGE NEEDS

The purchase of capital equipment and materials will of course be only one of the purposes for which foreign exchange will be needed. By far the largest requirement will be for imports for current consumption or fabrication. Foreign currencies will also be needed to pay ocean freight and marine insurance and for the expenses of Burma's diplomatic establishments abroad, travel abroad by residents of Burma, remittances by individuals in Burma to relatives abroad, dividend payments to stockholders abroad,

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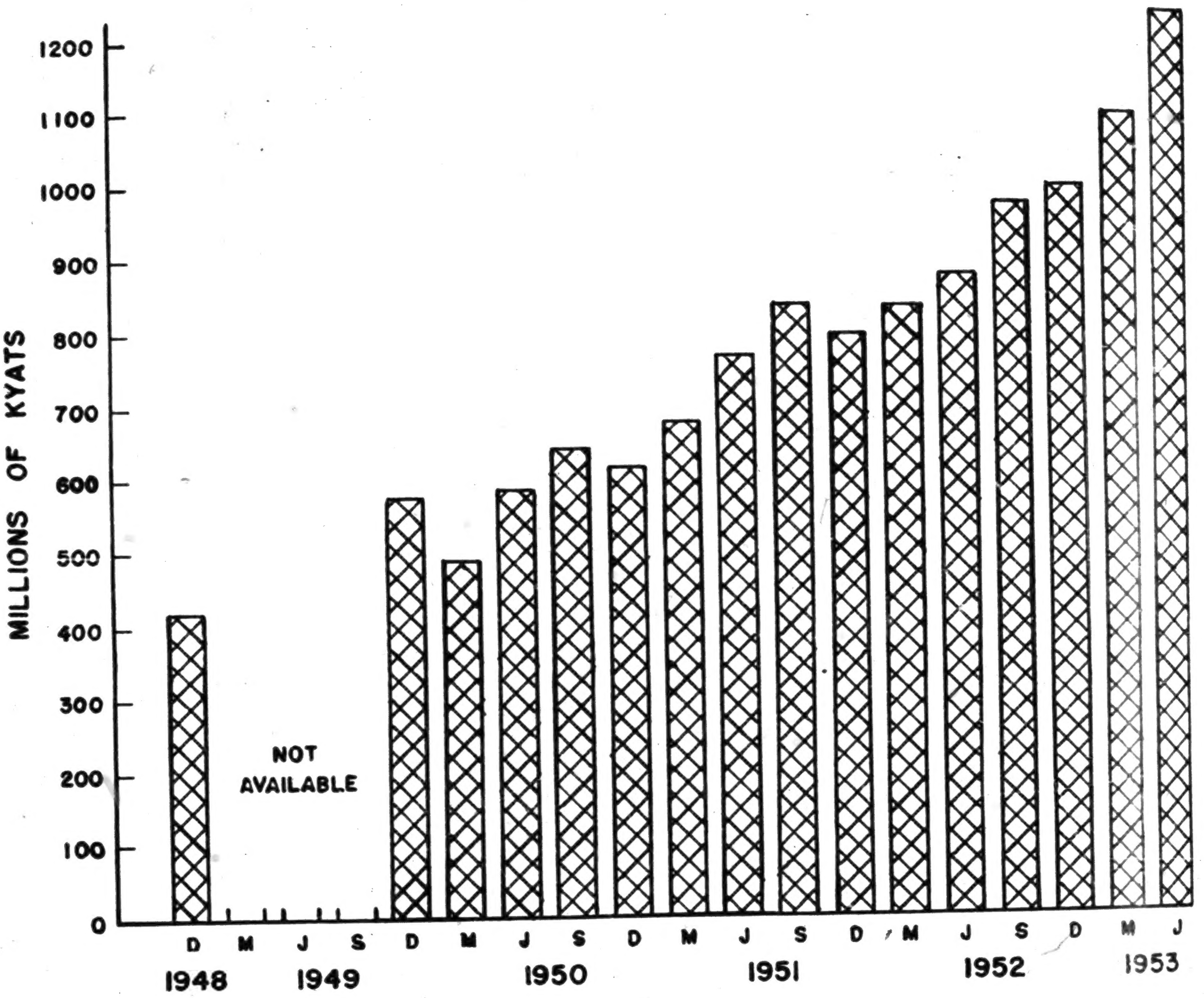
***It is estimated that in 1953–54 K25 million and in each subsequent year of the decade K50 million of normal depreciation will be made good by the development program expenditures themselves, since to some extent in creating new capacity they will replace existing obsolete equipment.**

DEPOSITS ABROAD ARE ACCUMULATING RAPIDLY



MINISTRY OF NATIONAL PLANNING

FOREIGN EXCHANGE RESERVES, 1948-1953

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P. DATE PLATE NO. 1
CK. BY J.L. JUNE 53

and for various other uses. If imports are left unrestricted, the magnitude of imports for consumer goods, of raw materials for fabrication, and of freight and insurance on both, will depend primarily on the level of output and income in Burma. So also will other minor foreign exchange expenditures. Past relationships between output and imports provide a basis for estimates of future trends. Table III–3 presents estimates of total foreign exchange payments during the remainder of the decade, together with data for recent years. Column 2 indicates the value of output in each year which is assumed in making estimates. The data present what is thought to be the most probable course of output and of foreign exchange expenditures if the development program proceeds as planned.

TABLE III – 3

ACTUAL AND ANTICIPATED FOREIGN EXCHANGE EXPENDITURES

(millions of kyats)

	1 *Year*	2 *Gross Domestic Product*[a]	3 *Imports of Productive and Social Capital*[b]	4 *Other Imports (including Military) and Net Non-trade Payments*[b]	5 *Total Foreign Exchange Payments*[c]
Actuals	1938–39	14	29	299[d]	328
	1946–47	2,928	81	640[e]	721
	1947–48	3,506	122	875[e]	997
	1948–49	3,224	51	507[e]	558
	1949–50	3,033	72	523[e]	595
	1950–51	3,710	74	750[e]	824
	1951–52	4,116	135	731[e]	866
Estimate	1952–53	4,650	135	830	965
Forecast	1953–54	5,200	362	980	1,342
	1954–55	5,550	430	1,075	1,505
	1955–56	5,950	464	1,160	1,624
	1956–57	6,300	467	1,230	1,697
	1957–58	6,600	447	1,300	1,747
	1958–59	6,800	407	1,355	1,762
	1959–60	7,000	405	1,430	1,835

[a] "Gross domestic product" is the value of the nation's production. The figures for 1951–52 and subsequent years reflect not only increase in output but also increase in the value of rice exported because of the rise in world rice prices. A gradual fall in rice prices from 1953 to 1960 is assumed. If rice prices had remained at the 1951 level throughout the decade, the approximate value of the nation's output for each year in millions of kyats would be: 1951–52, 4,070; 52–53, 4,500; 53–54, 5,000; 54–55, 5,400; 55–56, 5,800; 56–57, 6,200; 57–58, 6,500; 58–59, 6,750; 59–60, 7,000.

[b] Division of payments between components in past years is estimated.

[e] Net of non-trade receipts.

[d] Of this total, K85 million consisted of income payments abroad. Postwar income payments abroad have varied between K6 and K13 million per year.

[c] Payments for imports included in these figures differ considerably from the value of imports received during the year.

One type of payment which has decreased greatly since before the war is that to foreign owners of enterprises in Burma. In 1938–39 these payments were estimated at K85 million. If they had increased in the same ratio as prices they would now be K400 million or more per year. In fact in no postwar year have they exceeded K13 million. As noted in Chapter II, the decline results in part from transfer of ownership, in part from partial paralysis of export industries. It greatly influences present and prospective foreign exchange payments.

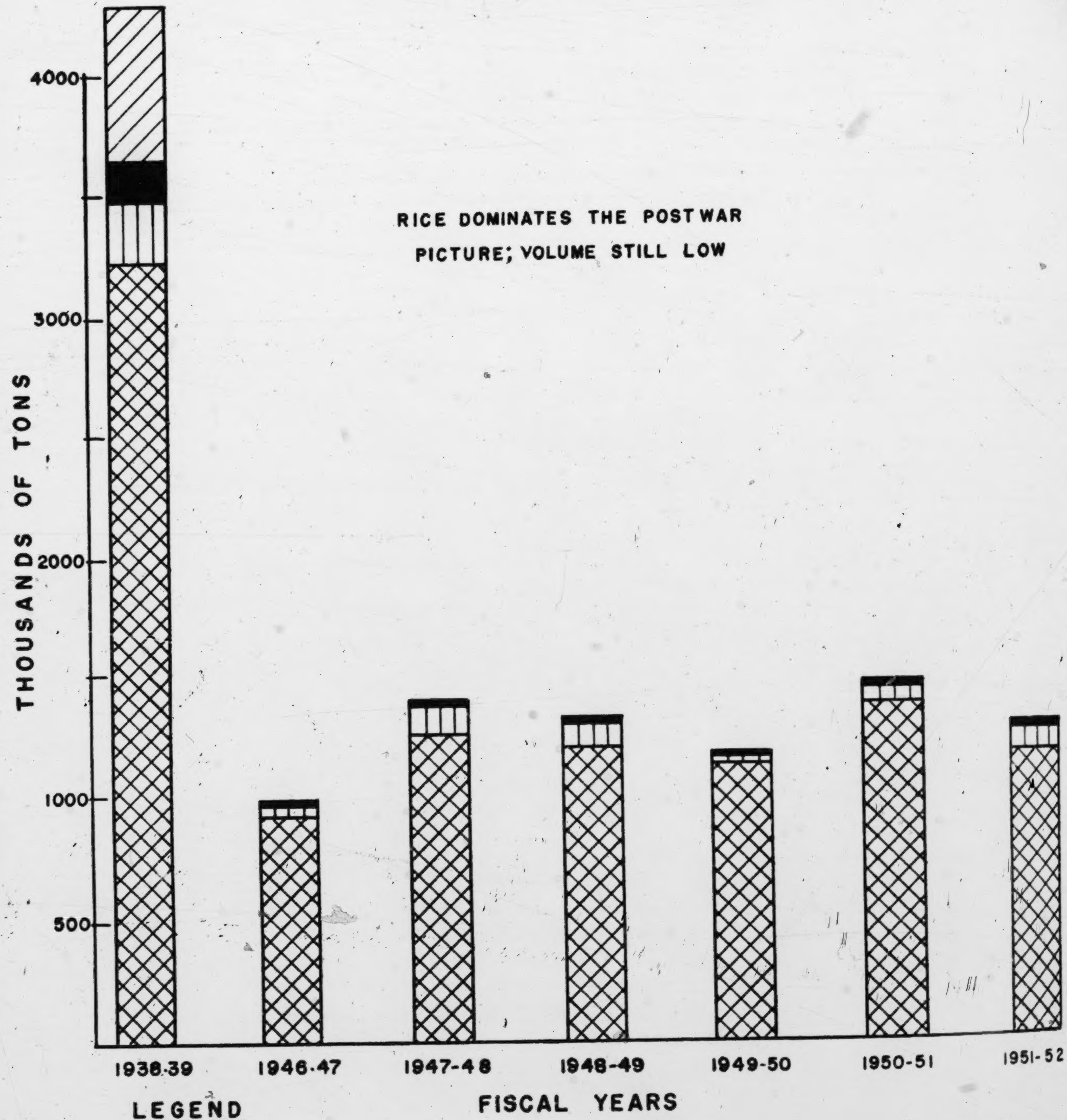
It should be emphasized that the general trend of foreign exchange expenditures shown in Table III–3 is more indicative of probable developments than are the figures for any one year. Large orders for capital equipment placed in any one year cause actual expenditures to swell in that year, and variation in the granting of import licenses may cause large swings in the year-to-year totals for imports. Even the figure for 1952–53 may differ greatly from the estimate, depending on the degree to which large capital purchases abroad being arranged as this is written are consummated and paid for by September 30. The table shows the trend which may be anticipated, but obviously does not allow for such variation. The table assumes unrestricted imports of consumer goods from non-dollar areas.

The table indicates that by 1959–60 the foreign exchange needs of Burma may increase to more than double the 1951–52 level and to about 90% above the present (1952–53) level. How will Burma be able to meet these needs?

2. FOREIGN EXCHANGE EARNINGS

Many small countries and some large countries during the past generation have been chronically short of foreign exchange with which to purchase required goods from abroad. This problem has been especially acute in recent years, because of needs for foreign goods arising out of wartime destruction and large-scale rehabilitation efforts. Foreign exchange shortage is normally made more acute by a development or rehabilitation program. Such a program directly creates a need for capital equipment and materials from abroad, and at the same time, by raising the level of economic activity and income, it increases the demand for imports for current use. Burma has shared the fear of other small countries of such a foreign exchange shortage. This fear was no doubt accentuated by the drain on her foreign exchange reserves in 1946–47 and 1947–48 and by the financial crisis of 1948–49.

But in Burma's case this fear is unnecessary. One of the most important economic facts concerning Burma is that the prospects for Burma to meet all of her foreign exchange needs out of the proceeds from her exports are favorable. A sizable excess of



SOURCE: QUARTERLY BULLETIN OF STATISTICS

MINISTRY OF NATIONAL PLANNING

MAJOR EXPORTS
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DR. BY. E.J.P. DATE
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PLATE NO. 2

foreign exchange receipts over foreign exchange payments has occurred in 1951, 1952 and 1953, in spite of relaxed restrictions on imports in the latter two years, and has resulted in a continuing increase in foreign exchange reserves (see Plate 1). Imports have been low because of the low level of national income. Expenditures for imports and other foreign exchange payments will increase steadily as income and output rise, and as annual development program expenditures rise, but a careful analysis of Burma's prospective foreign exchange earnings indicates that earnings are very likely to increase at least commensurately with payments. The excess of receipts is likely to continue even when consumer imports have risen further and when developmental expenditures are at their peak.

In the light of Burma's prewar record, this conclusion is not surprising. Though many Burmans do not realize it, even during the depression years of the 1930s Burma's exports earned foreign exchange far in excess of the amount required to pay for imports, plus shipping and insurance costs, plus substantial dividends to foreign owners of Burmese enterprises, plus all her other foreign financing needs. Large amounts of excess foreign exchange earnings were invested abroad annually. These amounts would have been more than sufficient to finance every year the annual foreign exchange requirements for a development program as large as that now recommended for Burma. Put another way, if Burma's prewar volume of exports and imports were re-established, the financing would be available for bringing in the productive equipment required for the proposed development program, even if price relationships were no more favorable than those which prevailed prewar. While data for "invisible" payments—freight, insurance, remittances to relatives—are not available for prewar years, data for exports and imports are available. Table III–4 shows the excess of exports over imports for five-year periods from 1901–02 to 1940–41. Hardly another small country in the world has a similar record:

TABLE III – 4

BURMA'S FOREIGN TRADE BALANCE 1901–1941

(millions of kyats, and percentages)

Year	*Exports*	*Imports*	*Excess of Exports*	*Per cent Excess of Exports*
1901–1906	210·6	145·1	65·5	45
1906–1911	304·8	184·0	120·8	66
1911–1916	356·8	211·8	145·0	68
1916–1921	457·6	282·3	175·3	62
1921–1926	660·2	365·7	294·5	81
1926–1931	661·2	362·6	298·6	82
1931–1936	485·6	201·3	284·3	141
1936–1941	519·2	250·8	268·4	107

Two offsetting influences distinguish export prospects of the 1950s from the 1930s. On the one hand, destruction and insecurity caused by the war and insurrection have brought a very sharp drop in the production of rice, minerals and timber, which made up most of Burma's exports (see Plate 2). Rice exports during the remainder of the 1950s will be smaller than before the war not only because production will be smaller, at least until the end of the decade, but also because the increased population will consume more. Because of the depletion of reserves of minerals at Bawdwin and Mawchi and the time required to explore or develop other prospective mineral sites, production and exports of minerals will also be below the prewar level. Exports of petroleum and products will be small or nil. Increased security could permit exploitation and export of timber and timber products considerably above the present level, but hardly above the prewar level.

But the reduction in the physical volume of exports has been compensated by favorable price trends. The relationship between the prospective world price level of rice and the price of import goods is the most important single determinant of Burma's foreign exchange situation. While the prices of goods imported by Burma have risen on the average to between four and five times their level in 1938–39, export prices for rice, the major export, now average about ten times the prewar level. The probability is strong that the terms of trade will continue to be favorable throughout the decade, though not in the same degree.

Factors influencing the price of rice have been reviewed and the opinions of world food experts have been checked. It is generally agreed that the prospects for the price of rice over the next few years are highly favorable. It is most unlikely that a full decline to the prewar relationship to industrial prices or non-food raw materials prices will occur during the next five to eight years.

3. PROSPECTIVE RICE EXPORTS

Table III–5A and III–5B (*see next page*) present alternative forecasts of Burma's earnings from the present to 1960 from rice exports, together with factors entering into the estimates. These are "intermediate" and "low" estimates; higher estimates which were also prepared are not presented. In order to estimate foreign exchange earnings with due conservatism, the intermediate estimate assumes paddy acreage by 1959–60 no higher and yield per acre a little lower than the targets set for 1956–57 in the Agricultural Five-year Plan. The low estimate assumes lower acreages and yields. Both also assume a decline in the average price received for rice exports below the present government-to-government prices of £60 per long ton (which in turn is below the present private market price). The intermediate estimate assumes a fall to about 8% below the present government-to-government price, or to £55; the low estimate a fall of about 16% to £50.

TABLE III – 5A

RICE OUTPUT, HOME USE, EXPORTS AND PROCEEDS

(*Intermediate estimates*)

Year	*Sown Acreage Paddy 1,000 Acres*	*Paddy Output 1,000 Tons*	*Paddy Home Use* 1,000 Tons*	*Available for Export, 1,000 Tons of Paddy*	*Available for Export, 1,000 Tons of Rice*	*Fiscal Year Exports 1,000 Tons of Rice*	*Export Price per Ton in Kyats*	*Value of Exports in Fiscal Year K Millions*	*Income to Private Sector K Millions*
1950–51	9,467	4,979	3,347	1,632	1,142	1,320†	563	745	415
1951–52	9,698	5,250	3,395	1,855	1,299	1,110†	720	787	436
1952–53	10,331	5,740	3,451	2,289	1,602	1,350‡	840	1,134	609
1953–54	10,781	5,950	3,502	2,448	1,714	1,886§	785	1,482	600
1954–55	11,198	6,180	3,556	2,624	1,837	1,806	800	1,445	643
1955–56	11,615	6,470	3,607	2,863	2,004	1,962	787	1,544	701
1956–57	11,979	6,730	3,659	3,071	2,150	2,114	773	1,634	752
1957–58	12,292	6,960	3,711	3,249	2,274	2,243	760	1,705	796
1958–59	12,604	7,200	3,764	3,436	2,405	2,372	747	1,772	841
1959–60	12,917	7,440	3,816	3,624	2,537	2,504	733	1,835	888

* Seed at 46 pounds per acre, annual per capita disappearance 125 kg. rice.
† Based on actuals.
‡ Estimate on basis of first three quarters.
§ Includes excess carryover of 198,000 tons.

TABLE III – 5B

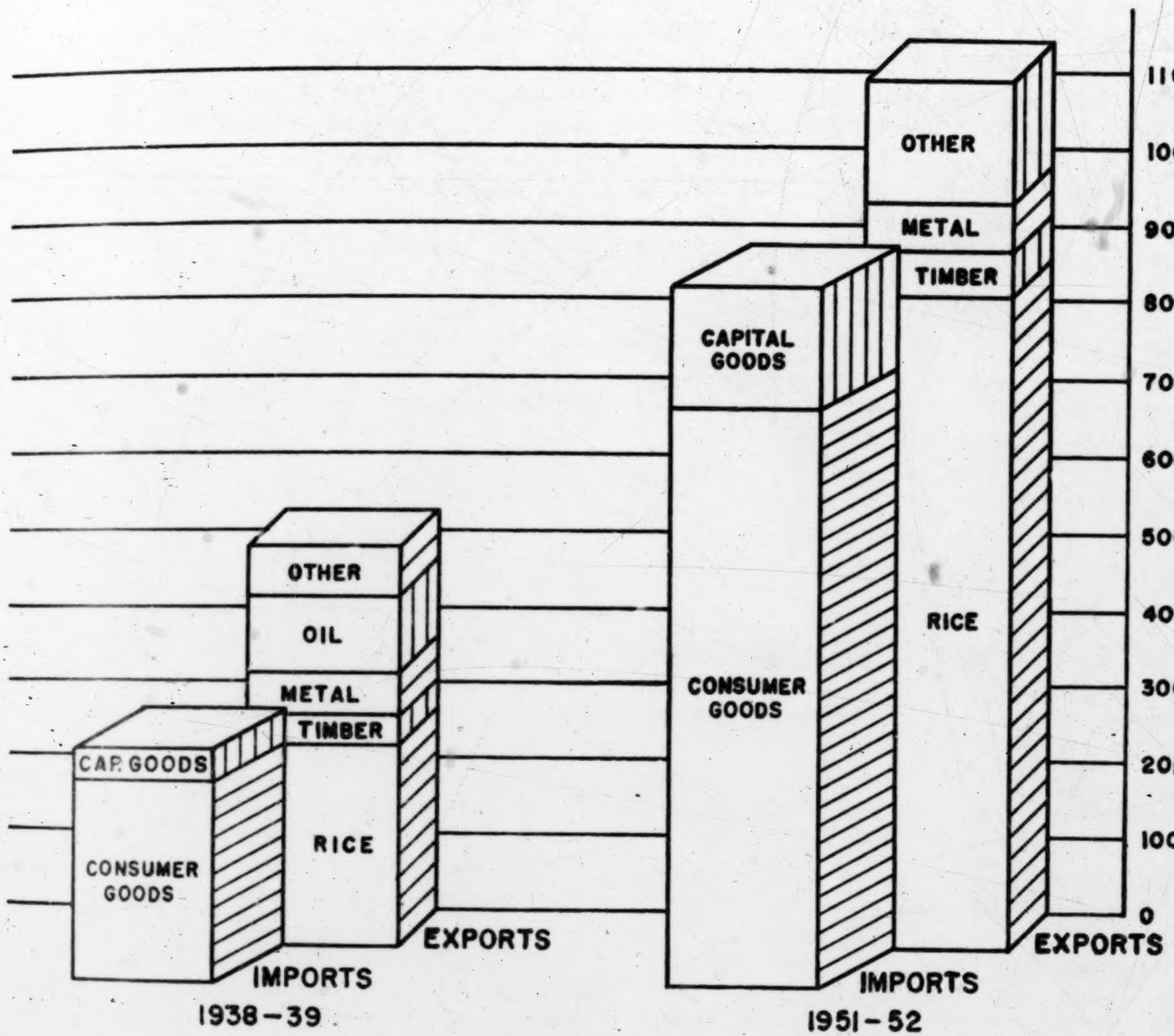
RICE OUTPUT, HOME USE, EXPORTS AND PROCEEDS

(*Low estimates*)

Year	*Sown Acreage Paddy 1,000 Acres*	*Paddy Output 1,000 Tons*	*Paddy Home Use* 1,000 Tons*	*Available for Export, 1,000 Tons of Paddy*	*Available for Export, 1,000 Tons of Rice*	*Fiscal Year Exports 1,000 Tons of Rice*	*Export Price per Ton in Kyats*	*Value of Exports in Fiscal Year K Millions*
1950–51	9,467	4,979	3,347	1,632	1,142	1,320†	563	745
1951–52	9,698	5,250	3,395	1,855	1,299	1,110†	720	787
1952–53	10,331	5,740	3,451	2,189	1,602	1,300‡	827	1,075
1953–54	10,300	5,870	3,493	2,377	1,664	1,898§	800	1,511
1954–55	10,600	6,040	3,544	2,496	1,747	1,726	773	1,334
1955–56	10,900	6,270	3,592	2,678	1,873	1,870	747	1,397
1956–57	11,200	6,500	3,643	2,857	2,000	1,969	720	1,418
1957–58	11,500	6,670	3,695	2,975	2,083	2,062	693	1,429
1958–59	11,800	6,900	3,747	3,153	2,207	2,176	667	1,451
1959–60	12,000	7,080	3,797	3,283	2,298	2,276	667	1,518

* Seed at 46 pounds per acre, annual per capita disappearance 125 kg. rice.
† Based on actuals.
‡ Estimate on basis of first three quarters.
§ Includes excess carryover of 248,000 tons.

VALUE OF EXPORTS AND IMPORTS BY COMMODITY



MINISTRY OF NATIONAL PLANNING

VALUE OF
EXPORTS AND IMPORTS
BY COMMODITY

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4. THE FAVORABLE BALANCE BETWEEN EARNINGS AND EXPENDITURES

Table III–6 combines the data of Tables III–4 and III–5A with estimates of receipts from exports other than rice. These estimates too are conservative; they assume that even by 1959–60 the physical volume of other exports will still be much below that before the war. These exports will include metallic minerals, teak and other timber, a variety of agricultural products, rubber and miscellaneous other commodities. Total receipts in 1959–60 only 75% above prewar are assumed. Plate 3, Value of Exports and Imports by Commodity, compares the prewar and postwar exports and imports of major commodity groups.

TABLE III – 6

PROSPECTIVE FOREIGN EXCHANGE EARNINGS AND EXPENDITURES

(millions of kyats)

Fiscal Year	*Receipts : Intermediate Estimates*			*Payments* (Table III – 3)*	*Excess of Receipts*
	From Rice Exports	*From Other Exports*	*Total Receipts from Exports*		
Actual	(Table III - 5A)				
1938–39	218	267	485	328	157
1950–51	745†	242†	991	824	167
1951–52	787†	280†	1,025	866	159
Estimated					
1952–53	1,134	260	1,394	965	429
Forecasts					
1953–54	1,482	300	1,782	1,342	440
1954–55	1,445	320	1,765	1,505	260
1955–56	1,544	340	1,884	1,624	260
1956–57	1,634	370	2,004	1,697	307
1957–58	1,705	400	2,105	1,747	358
1958–59	1,772	435	2,207	1,762	445
1959–60	1,835	470	2,305	1,835	470

* Net of non-trade receipts.

† These data are customs data for value of exports. Unreconciled discrepancies exist between them and total receipts from exports shown in the adjacent column.

The table shows receipts during 1953–54 to 1959–60 K2,540 million in excess of expenditures. That is, it shows proceeds from exports during the seven years sufficient to finance unrestricted imports for current purposes, plus all purchases abroad for the development program, with a surplus in addition to the present large foreign exchange reserves of K2,540 million.

As in the case of Table III–3, the general trend of the figures is much more significant than those for any given year, which are subject to fluctuation.

If the low receipts estimates of Table III-5B are substituted for the intermediate estimates, the forecast still shows a balance of foreign exchange earnings over receipts of more than K1,100 million over the seven-year period. The price of rice would have to fall to £45 by 1959–60, or to fall abruptly below £55 in the near future and continue down thereafter, to create a deficit of foreign exchange for unrestricted imports. What is the probability that such a fall or a greater fall will occur?

Should generally depressed conditions emerge in the world economy, or should peace and conditions favorable to maximum rice production occur in all major rice producing countries, rice prices might fall more than other prices but hardly to prewar relations. If rice were to sell at £50 per ton by the end of the decade and other prices remain stable, then almost one third of the present advantageous level of rice prices relative to other prices will have been eliminated. If the price of rice drops to £45 per ton and other prices remain stable, then almost half of the relative price advantage which rice enjoys over other products today in relation to prewar levels will have been eliminated. In face of all the influences which can be evaluated, this would appear to be very unlikely. Far more likely is the probability that future declines in the price of rice will be partially offset by lesser declines in other prices.

The analysis thus far has treated the forward period to 1959–60 as a whole, and has contemplated continuous trends throughout it. This does not exclude the possibility of a drop in price within any year of this period more substantial than those indicated. However, it is believed that any such sharper drop, relative to other prices, would probably result from a temporary combination of circumstances which would not invalidate the analysis for the longer period.*

5. PRESENT FOREIGN EXCHANGE RESERVES

The future, however, cannot be foreseen clearly, and a greater fall in foreign exchange receipts relative to payment is possible. If it should occur, Burma would have to rely on one of three other procedures to finance imports for economic development.

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* Subsequent to the completion of the mimeographed edition of this report, Burma has concluded long-term agreements with Ceylon and Japan at price schedules below those indicated above. The new price schedules, if applied to all rice sales and extended throughout the period 1953–54 to 1959–60, would reduce substantially the sizable addition to foreign exchange predicated. However, the basic conclusion, namely, that Burma will probably be able to finance her development program entirely from present foreign exchange availabilities, plus earnings during the period, would remain unaffected. This would also be true even if average prices for the entire period were some 10% below those of the Ceylon agreement. This would not preclude prices more than 10% below the Ceylon schedule in any given year of the period.

One of these is use of some of her present foreign exchange "reserves," i.e., present deposits and investments abroad.

At the end of June, 1953, these totaled over K1,200 million. Of this amount, less than one third is needed as statutory reserves of the Union Bank of Burma (which could of course be reduced by statute). Because an adequate reserve should be held to meet seasonal swings in foreign exchange payments, the minimum reserves held should perhaps be larger, or half of the present total. Even so, K600 million of present deposits and investments abroad could safely be used to finance imports if desired.

6. CURTAILMENT OF IMPORTS

The second additional available procedure is restriction of imports. The estimates presented above assumed completely unrestricted imports from non-dollar areas. It would not require severe restrictions to divert, say, K100 million per year, during the last years of this decade from other imports to imports for the development program.

7. INTERNATIONAL LOANS

Finally, Burma could request loans from abroad. It seems very probable that such loans could be obtained for resource development which directly or indirectly would increase the country's capacity to export and thus to repay loans.

In view of the very favorable earnings prospects and the availability of these supplementary procedures, it is hardly conceivable that Burma will not have adequate foreign exchange to finance the full development program which has been recommended. She should proceed with her development program with no hesitation whatsoever on this score.

8. DOLLAR IMPORTS

The discussion above has applied only to imports from non-dollar sources. Though Burma will probably earn ample sterling and other non-dollar foreign exchange in relation to her maximum requirements, the same will not be true of United States dollars. The United States is herself a rice exporter, and for the present she has advantageous alternative sources of supply for most other materials which Burma exports. Burma's earnings of dollars will be derived mainly from fairly small sales of some minerals, and perhaps from the sale of rice to United States forces in the Pacific or to countries in the Pacific area which have dollars available for payment. On the other hand, Burma's imports of United States products for consumption are not large. Indeed for most items other sources of supply can be substituted without hardship, even though there may be consumer preferences for the United States product. There will remain some consumer items and some items of capital equipment with respect to which an advantage in price, performance, or speed of delivery justifies procurement from dollar areas.

Burma's direct dollar earnings will probably not be great enough to meet her requirements for consumer goods and capital equipment from the United States and other dollar areas. Wherever and whenever opportunities present themselves for exports for dollars, advantage should be taken of such opportunities. As a contributor of important quantities of commodities to other sterling area countries, Burma will very probably be able to obtain from the sterling area dollar pool the moderate amount of dollars needed to supplement these sources. While the amount required will be of considerable importance to Burma, it will not bulk large in relation to the sterling area dollar pool as a whole. Burma can therefore expect to finance without difficulty her reasonable needs for dollars as well as non-dollar imports.

The prospective availability of ample amounts of foreign exchange, of course, has important implications with respect to foreign exchange and foreign trade policy. These are discussed in Chapter IV.

C. FINANCING DEVELOPMENT EXPENDITURES WITHIN BURMA

It is a truism that when an economic system is operating at capacity, the amount of investment (capital formation) undertaken must be matched by an equal rate of saving. Yearly capital formation in excess of the year's savings will cause scarcities and inflation. This statement requires only the qualification that if capacity is expanding, this expansion creates room for a slight excess of investment.

On the other hand, if production in the country is below capacity—if there is underemployment and slack—then it is highly desirable that capital formation should exceed saving in order that the excess of expenditures for capital formation may create new jobs, increase employment and incomes, and pump new money into circulation.

These economic axioms apply in Burma as elsewhere. However, these generalizations do not provide a guide to the amount of development expenditures within Burma which the country can successfully finance. It is necessary to answer such questions as: How much saving by firms and individuals can be anticipated? How much saving can the Government do? Exactly what is meant by "government saving"? If capital formation in excess of saving is anticipated, how large an amount, in the present slack state of the economy, is desirable?

These questions are considered in this section. The conclusion is reached that the contemplated programs of private investment and of government investment are both feasible. Whether present revenue measures and related policies are adequate to finance the Government's program, or on the contrary new measures are needed, is uncertain. The relationship of government revenues to expenditures and the trend in the money supply must be watched from year to year to decide whether and when new measures may be needed.

1. GOVERNMENT AND PRIVATE INVESTMENT

It will be convenient to consider separately the financing of government and private investment, and, as the first step, to estimate the amount of each. Of total capital expenditures of K6,600 million anticipated during the remaining seven years of the development program, planned projects recommended in this Report will require a little more than K3,000 million. It is reasonable to suppose that the Government itself will execute almost all of these. Some, however, in industry and possibly in mining may be joint ventures. Capital expenditures by the Government on presently planned projects during the years 1953–54 to 1956–57 are therefore assumed to be moderately below the total expenditures for planned projects in these years programmed in Part VIII. On the other hand, it is assumed that with continuing planning, a number of additional projects will be planned before the end of the decade. Government expenditures on planned projects during 1957–58 to 1959–60 are therefore assumed to be somewhat above the totals now programmed for planned projects during those years.

In addition to the planned productive projects, the Government will build houses, schools, health facilities, and other social capital, and government buildings of various types for administrative purposes. It is reasonable to estimate this construction at a rate rising throughout the seven years but averaging about K100 million per year or K700 million in all. Total capital expenditures by the Government may be estimated at K3,650 million. Private net capital formation, the balance of the development program, will be considerably less than that by Government, or K2,950 million.

These are "net" figures, that is, figures for the necessary increase above the present amount of productive and social capital. In addition, some capital must be built every year to replace the depreciation of existing capital which goes on year by year. Also, Government must construct a considerable number of buildings and buy considerable capital equipment for the defense forces, not included in the preceding figures. Capital formation by the Government for these two purposes will total almost K1,000 million during the seven-year period, bringing the estimated Government total to K4,620 million. Private capital formation to make good depreciation is much larger than that by government, both because the existing amount of private capital is larger and because houses constructed of bamboo and thatch must be completely replaced every three to five years. Private capital formation to offset depreciation is estimated at K1,655 million for the seven-year period, and total private capital formation at K4,605 million.

These estimates are used as the basis for the discussion which follows. The pattern which the capital expenditures may take over the seven-year period is indicated in Table III–7.

TABLE III – 7

GOVERNMENT AND PRIVATE CAPITAL FORMATION, 1953–54 to 1959–60

(millions of kyats)

1	2	3	4	5	6	7	8
Year	*Gross Domestic Product*	*Government Capital Formation*		*Private Capital Formation*		*Per cent Col. 4 to 2*	*Per cent Col. 6 to 2*
		Productive and Social —Net	*Productive and Defensive— Gross*	*Net*	*Gross*		
Jan.–Sept. 1952	4,121	150	230	255	385	5·6	9·3
1952–53 (est.)	4,650	220	375	265	460	8·1	9·9
Programmed:							
1953–54	5,200	390	565	265	470	10·9	9·0
1954–55	5,550	550	695	280	495	12·5	8·9
1955–56	5,950	605	745	345	570	12·5	9·6
1956–57	6,300	605	740	410	645	10·7	10·2
1957–58	6,600	540	670	490	735	10·2	11·1
1958–59	6,800	490	615	560	815	9·1	12·0
1959–60	7,000	470	590	600	865	8·4	12·4
Total, 1953–54 to 1959–60		3,650	4,620	2,950	4,595		

2. FINANCING PRIVATE CAPITAL FORMATION

These estimates, of course, include both expenditures within Burma and purchases of materials and equipment abroad. If foreign firms invest in Burma and bring capital in from abroad, no saving within Burma is needed to finance this capital. However, if private firms within Burma invest, they must surrender funds here in Burma to the foreign exchange authorities to obtain the foreign currency needed for purchases abroad. Hence total private capital formation, i.e., the expenditures both abroad and in Burma, may have to be financed out of savings within Burma.

Government expenditures for productive capital reach a peak in 1956–57, mainly because of the urgency of key power and transport projects. (See Parts IV and VI, and also Part VIII, which summarize expenditures on planned projects.) Private capital formation is expected to be stimulated by these key public projects and to rise rapidly during 1955–60.

Private saving within Burma will almost certainly be ample to finance the total shown. The financing of that share which makes good each year's depreciation raises little question, since it will be covered by the provisions for depreciation normally made by business firms, plus the arrangements for regular replacement of short-lived housing customarily made by the inhabitants. For many individuals and firms in the Burmese economy, these arrangements are not formalized, but the provisions do exist, and in a period of rising income they are easy to make. Hence attention can be concentrated on the financing of the net private additions to capital.

Private net capital formation is estimated to rise from K265 million in the current year, 1952–53, to K600 million in 1959–60. In 1952–53, it constitutes 5·7% of the value of the nation's output; in 1959–60, this percentage will have risen to 8·6% of the much larger national output of that year.

The private capital formation in 1952–53 was financed wholly from current private saving, except for some agricultural improvements financed by government loans to cultivators. Loans and advances by commercial banks diminished during the year. This indicates that the saving by individuals and firms during the year was sufficient not only to finance the capital formation which occurred (other than the agricultural improvements mentioned), but also to make loan repayments to the banks.

If private savings rise during the remainder of the decade from 5·7% to 8·6% of the value of the nation's output, they will be sufficient to finance all of the private capital formation which is anticipated.

They will almost certainly rise by at least this amount. During the six years intervening the nation's output (and income) will increase by more than one third, and per capita income will increase by approximately 25%. With such a rise in per capita income the percentage of income saved by individuals and firms always rises fairly sharply. In 1938–39, with per capita income slightly below that anticipated in 1959–60, private saving totaled 14·2% of the value of the nation's output. Private activity in that year included a number of industries since wholly or partly nationalized (rice exporting, teak extraction, mining, Irrawaddy flotilla), and the profitable mineral extraction industries will be operating at much lower levels of activity in 1959–60 than before the war, so that private saving cannot be expected to equal the prewar percentage of the value of the nation's output, 14·2%; but that it will reach 8·6% or more seems reasonably certain. The prospects are good, not only that private saving will readily finance all of the private capital formation anticipated, but that if private capital formation does not exceed this amount there will be savings looking for outlets and available for the purchase of government bonds.

3. FINANCING GOVERNMENT CAPITAL FORMATION

Column 4 of Table III–7 indicated anticipated expenditures for government capital formation year by year, including not only those within the development program but also those for defense capital and those needed to offset each year's depreciation. Table III–8 indicates the probable division of this total between expenditures abroad and those within Burma.

TABLE III – 8

GROSS GOVERNMENT CAPITAL FORMATION, INCLUDING DEFENSE, AT HOME AND ABROAD

(millions of kyats)

Year	*Total*	*Abroad*	*At Home*
Jan.–Sept., 1952	230	40	190
1952–53 (est.)	375	150	225
Programmed:			
1953–54	565	303	262
1954–55	695	356	339
1955–56	745	360	385
1956–57	740	352	388
1957–58	670	312	358
1958–59	615	267	348
1959–60	590	259	331
Total, 1953–54 to 1959–60	4,620	2,209	2,411

The preceding section has indicated that ample foreign exchange will be available to finance both private and government expenditures abroad. The remaining question concerning the financing of the entire development program is whether any new measures must be adopted to finance without economic strain the domestic expenditures by the Government, or whether present measures and economic policies are adequate.

The expenditures within Burma must be financed out of current government receipts by drawing on accumulated cash balances, or by creating new money.

a. The Government's Budget

The primary source of funds must of course be government revenues (though as will be noted below this is by no means the only important source). Government revenues do more than merely provide income for the Government. The taxes paid by individuals and firms curtail their purchases of goods and services. In the main, therefore, government spending of its revenues merely replaces private spending. But, unfortunately so far as their use in financing government expenditures within Burma is concerned, a large part of the present revenues of the Union Government are not paid by the people or firms of Burma and do not curtail private spendings within Burma. By far the largest single source of budget revenues since the war is the taxes or contributions paid by the State Agricultural Marketing Board from its net income or "profits" on rice exports. This revenue is derived from foreign buyers of rice. It is in fact received in foreign currencies—checks or drafts on foreign banks—and not in kyats. It is converted into kyats by selling it to the Union Bank of Burma, which holds the deposits abroad and creates new deposits, exactly as it would if it bought government bonds. This revenue does not in the least reduce private spending in Burma or free labor or other resources in Burma for employment by the Government. To the extent that withdrawal of funds from private spending may be necessary to prevent inflation, such revenues must be disregarded for financing expenditures within Burma. However withdrawals in addition to those accomplished by the present structure of the Government's domestic revenues are not inescapable, as developed further in paragraph e.

The importance of this fact may be seen by considering the 1952–53 budget. (The original budget estimates, presented to Parliament in August, 1952, are used.) The budget estimated total receipts of K835 million—K699·4 million of "revenue receipts" and K135·5 million of "capital receipts." But of the total, K364·6 million consisted of revenues from SAMB—a "rehabilitation contribution" of K250 million, export duties of K14·6 million, and a "capital contribution" of K100 million. Only the remaining K470·4 million was from within Burma.*

To determine the amount of government revenues available for capital formation within Burma, this sum must be set against the Government's expenditure within Burma for other purposes. The budget for 1952–53 showed total "current expenditures" of approximately K655 million. Of this total however about K30 million are actually capital expenditures for the rehabilitation of buildings destroyed or damaged in war or insurrection. Only K625 million are true "current expenditures." To these must be added expenditures included in the capital budget which are not for physical capital formation. They include part of the loan to the Burma Railways (to cover its operating deficit for the year, the remaining part being for capital formation), and loans to agriculturists, cooperative societies and others. These loans total about K50 million, bringing total non-capital-formation expenditures to K675 million. Of these, about K100 million are abroad (the largest single category being defense purchases abroad) and K575 million in Burma.

This figure is K105 million in excess of revenues from within Burma. The contrast between this fact and the over-all budget data, which include revenues and expenditures both at home and abroad, is striking. Though there is a budget surplus of K180 million over current expenditures, there is a deficit of K105 million of revenues within Burma below non-capital expenditures within Burma. The reason for this discrepancy is that the budget estimates include a huge surplus of estimated revenues abroad over estimated expenditures abroad. Such amounts are not relevant to an analysis of financing within Burma.

BUDGET ESTIMATES, 1952–53, SELECTED DATA
(millions of kyats)

Revenues (current plus capital)	835·0	Revenues from within Burma	470
Current expenditures	654·9	Non-capital expenditures within Burma	575
Surplus available for capital expenditures	180·1	Surplus available for government capital formation in Burma	105

The table, it should be noted, is based on the original budget estimates. An estimate may be hazarded that current budget expenditures within Burma during 1952–53 will total some K40 to K50 million less than the budgeted amount, while revenues will approximate the total indicated, so that the actual deficit is K40 million less than indicated in the table.

Estimates may be made of the corresponding surpluses or deficits of domestic receipts compared to domestic non-capital-formation expenditures, during the period 1953–54 to 1959–60. To do so, receipts and expenditures must be forecast. As national income rises, revenues will rise significantly even without change in present revenue laws. (A new schedule of tariff rates will take effect on October 1, 1953, with termination of the preferential agreements now in effect. The estimates below assume that the new rates will yield the same total revenue as the former ones.)

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*There are other minor sums derived from abroad, but these are so small that they may be disregarded.

In forecasting expenditures, account must be taken of the fact that a number of types of current expenditures for education, health, other social services, and general administration are being expanded fairly rapidly. Such other expenditures as those for technical education and training, research and extension work must expand if the development program is to be carried out effectively. Because of these expanding programs, current budget expenditures will rise steadily year by year unless they are firmly controlled, and in fact may over a period of several years threaten the success of the development program. Current expenditures (at home and abroad) budgeted for 1952–53 are K650 million. In the estimates below, it is assumed that those budgeted for 1953–54 will total K700 million, and that they will be held at this level in subsequent years. This is not merely a forecast of present trends. Such a forecast would present increasing figures in subsequent years. The figure is held at K700 million because it is believed that the Government must hold it at approximately this level if enough resources are to be available for the development program.

It was noted that current expenditures in 1952–53 will probably not reach the budgeted level. Similarly, it is estimated that those in 1953–54 will not reach the higher level which will presumably be budgeted for that year, but that they will reach this level in subsequent years.

TABLE III – 9

BUDGET SURPLUSES AVAILABLE FOR EXPENDITURES IN BURMA FOR CAPITAL FORMATION
1952–53 to 1959–60
(millions of kyats)

1 *Year*	2 *Revenues from within Burma (Current plus Capital)*	3 *Expenditures within Burma Other than for Capital Formation (In Current and Capital Budgets)*	4 *Available for Expenditures in Burma for Capital Formation*
1952–53	470	525	–55
1953–54	530	540	–10
1954–55	580	585	– 5
1955–56	630	580	50
1956–57	670	575	95
1957–58	705	570	135
1958–59	735	570	165
1959–60	760	570	190

Table III–9 presents the estimates. The decline in non-capital-formation expenditures in the years following 1954–55 reflects the anticipated decline in the operating deficit of the Burma Railways from between K20 and K30 million this year to a "black ink" budget by the end of the decade.

Table III–9 indicates that not until 1955–56 will the domestic revenues and expenditures provided in the budget yield a surplus for capital formation expenditures within Burma. These estimates, however, give by no means a complete indication of the funds available. It was suggested above that there are important sources of funds outside the budget. These must also be considered.

b. Sources of Funds outside the Budget: State Enterprises and Minor Funds

As the functions of the Union Government have expanded and diversified in recent years, an increasing number of government activities are carried on by State enterprises whose receipts and expenditures are reflected in the budget only insofar as they suffer losses which must be met by appropriations from the budget, or as they obtain an appropriation of capital or make a repayment of capital. Among these are the Inland Water Transport Board, Burma Railways, the Board of Commissioners of the Port of Rangoon, and the Union of Burma Airways. There are many others. The losses of those boards consistently incurring losses, notably Burma Railways, are reflected in the budget. The net profits of the enterprises earning profits are not. Those profits, plus the share of their gross receipts allocated to depreciation and certain other reserve accounts, are available for capital expenditures. So also are the net deposits by the public in various government court, civil and savings funds. These are minor in amount. Offsetting these non-budget receipts in part are disbursements

TABLE III – 10

NET NON-BUDGET RECEIPTS
(millions of kyats)

Year	*Amount*
1952–53	100
1953–54	105
1954–55	110
1955–56	115
1956–57	120
1957–58	125
1958–59	130
1959–60	140

of funds not reflected in the budget, such as the net loans of the State Agricultural Credit Bank created in 1953.

While the net receipts from this group of sources can be estimated only very roughly, it will clearly rise through the period of the development program. Table III – 10 (*see p.* 53) shows the estimated receipts.

c. Private Saving as a Source of Funds

A third prospective source of funds is private saving. It was suggested above that private saving may rise more rapidly than private capital formation. If it does, the firms whose savings exceed their capital needs may come into the market for government securities; or, as has happened in 1952–53, they may use excess funds to retire loans from commercial banks, while the banks in turn purchase government securities. In either case, the funds will be available for government expenditures.*

The estimates of capital receipts above include a nominal estimate of K10 million per year from this source. As national income rises, the amount available annually may be considerably greater. In calculating the prospective financial position, from zero to K50 million per year may be allowed from this source.

d. Government Receipts and Disbursements: Consolidated Estimate

A consolidation of the estimates presented in the preceding sections will indicate the relationship between prospective domestic receipts and disbursements of the Government and all of its agencies. Table III–11 presents the data. The term domestic receipts as used here includes both budget receipts from within Burma and the gross income (net profits plus accruals in depreciation reserves) from within Burma of all agencies operating outside the budget. The term domestic disbursements includes both the disbursements within Burma recorded in the budget accounts and the capital expenditures of the agencies outside the budget. Such a consolidated picture presents information concerning the impact of the development program on the economy which cannot be gleaned from the Government's budget data.

The excess of disbursements would have to be financed from accumulated cash balances or from new money (i.e., new deposits) created for the purpose.

TABLE III – 11

DOMESTIC RECEIPTS AND DISBURSEMENTS, 1952–53 to 1959–60, ALL UNION GOVERNMENT AGENCIES, CONSOLIDATED

(*millions of kyats*)

1	2	3	4	5	6
Year	*Consolidated Domestic Receipts Including Loans from Current Private Income**	*Consolidated Domestic Disbursements*			*Excess of Disbursements*
		Non-Capital Formation	*Capital Formation*	*Total*	
1952–53	630	525	225	750	120
1953–54	635–685	540	262	808	123–173
1954–55	690–740	585	339	924	184–234
1955–56	745–795	580	385	965	170–220
1956–57	790–840	575	388	963	123–173
1957–58	830–880	570	358	928	48–98
1958–59	865–915	570	348	918	3–53
1959–60	900–950	570	331	901	(−49)–(−1)

* The lower figure in this column is from column 2 of Table III – 9 and Table III – 10. This figure (for each year) includes K10 million of receipts from the sale of securities to persons or firms who purchase out of current income; the higher figure includes K60 million.

From a purely financial viewpoint, there would be no difficulty in obtaining these funds. The commercial banks will probably be in the market for government securities in considerable amounts. (Their purchases will automatically create new deposits.) Further, under present statutes and with present reserves, the Union Bank of Burma possesses the authority to create new deposits or issue new currency vastly in excess of foreseeable requirements, and if desired, by statutory change the authority could be made limitless.† Actually, no deposit creation would be required for some time; the accumulated cash balance of the Union Government in the bank totaled K511 million at mid-1952. Only a fraction of this amount is needed as minimum reserve.

The creation of new deposits would not necessarily require securities purchases from the Government either by the Union Bank or by the commercial banks of the country. It was noted earlier in this chapter that the State Agricultural Marketing Board converts its foreign revenues into kyats by selling them to the Union Bank, which creates new deposits in return. Such deposit creation is the source of the Government's present cash balance. Any excess of SAMB revenues in near-future years over the foreign exchange needs of the Government will result in additional deposit creation. The amount of this will probably be sufficient to finance the excess of domestic disbursements over domestic receipts shown in Table III–11. If however this should not be the case, securities issues to the Bank could be used.

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* Or private savers may hold funds idle, and the banks may offset this by the purchase of government securities. The effect on the money supply will be different from that if bank loans are retired, but the effect on funds available for investment will be the same.

† Present law requires the Bank to hold foreign exchange equal to 25% of its deposits plus currency outstanding, or, in other terms, permits creation of deposits or issue of new currency equal to four times the foreign exchange holdings. At the end of April, 1953, foreign exchange holdings of the Bank totaled K1,041 million. This would permit deposits or currency totaling K4,164 million; the actual amount at that date, on the basis of a preliminary estimate, was about K1,120 million. The theoretically permissible increase of more than K3,000 million is vastly in excess of any conceivable increase which will be desirable or which will be undertaken.

e. Effects on the Money Supply

The question to which these estimates lead is not therefore whether the money can be obtained. The answer to that question is obvious. The pertinent question is whether the prospective excess of government domestic disbursements over receipts indicated in Table III–11 is healthy, or whether it is excessive. In the latter case, if domestic disbursements progress as indicated, measures should be taken by the Government to increase its domestic revenues.

It has already been noted that in the conditions of slack and underemployment which now prevail in the Burmese economy, government expenditures within Burma on capital projects in excess of current government savings—or, in other words, total domestic disbursements by the Government in excess of its total domestic receipts—are highly desirable. They create jobs and increase the level of income, and in the process inject into the economy the increase in money supply needed to provide working capital for the increased production which is stimulated by the increased spending. Of course there is a limit to the rate at which new orders for materials should be placed, but this is a question of bottlenecks in the production of specific materials (such as construction materials) and in the availability of skilled workers of specific types, and not a question of the total rate of spending. The advisability of a given total rate of spending will be tested by the presence or absence of general scarcities, scarcities of most types of goods and of most kinds of labor, when the economic system approaches capacity. One convenient way to test this is to ask whether government programs will still be increasing the total money supply in private hands when the economic system is operating at capacity, and whether in the interval before capacity operation is reached government disbursements will have contributed so much new money that its presence in the hands of the public will in itself stimulate excessive spending and create scarcities and inflationary pressure.

These pressures, however, may be mitigated by two other factors: the loan policies of commercial banks, and import-export operations. The former will probably be a fairly passive factor in the circumstances facing Burma, but the balance between receipts and payments of firms and individuals in importing and exporting and in related foreign exchange transactions will be an important influence, offsetting in part the excess of government domestic disbursements over receipts.

When an individual or firm makes a payment abroad—for imports, ocean freight, marine insurance or other remittances abroad—he surrenders funds to his bank in order to purchase the necessary foreign exchange. This decreases the total money supply in Burma. On the other hand when he receives a payment in a foreign currency, he sells the foreign draft to his bank, which creates a new deposit in exchange; this increases the total money supply. This "monetization" of foreign exchange is a normal part of banking operations. When SAMB is the exporter, it receives the new money (from the Union Bank) and may hold part of it idle, but its payments to firms or individuals for rice purchased for export increase the money supply in private hands.

If the total income of firms and individuals from exports exceeds private payments abroad for imports, the money supply in the hands of firms and individuals is increased; if the payments abroad exceed receipts, the money supply is decreased.

Preliminary data suggest that during 1952–53 receipts from exports by firms and individuals and from rice sales to SAMB exceeded their payments abroad by K110 million. This increase, combined with an excess of government domestic disbursements over receipts of K120 million, offset in part by a K30 million contraction of bank credit, increased the money supply in private hands by K200 million. (These are estimates based on nine months' data, and may be inexact. The increase in money supply in private hands will however obviously be between K160 and K220 million.) The excess of receipts from sales for export was due in large part to unusually large purchases of rice by SAMB. Since rice and paddy stocks in private hands are now probably down to a minimum, SAMB purchases in 1953–54 may be below those in 1952–53 in spite of a larger crop. Other exports will probably rise, and in subsequent years both other exports and rice sales for export will rise. At the same time, however, with increasing incomes the people will spend increasing amounts for imports; and as private capital formation increases they will also spend increasing amounts abroad for the purchase of capital equipment and materials. It seems probable that purchases of foreign exchange in 1953–54 to pay for imports will almost equal receipts by individuals and firms from exports, and that in subsequent years they will exceed receipts, thus causing a shrinkage in the money supply which will offset in part the effect of government expenditures.

Table III–12 (*see next page*) presents estimates of

TABLE III – 12

CHANGES IN THE PRIVATELY HELD MONEY SUPPLY DUE TO FOREIGN EXCHANGE TRANSACTIONS

(*millions of kyats*)

Year	*Private Imports of Consumer Goods and Materials and Non-Trade Payments*	*Private Imports of Capital Equipment and Materials*	*Total Foreign Exchange Payments*	*Receipts from Exports plus Rice Sales to SAMB*	*Excess of Receipts (Increasing Money Supply)*
1952–53	671	104	775	885	+110
1953–54	770	139	909	900	− 9
1954–55	865	147	1,012	970	− 42
1955–56	955	171	1,126	1,040	− 86
1956–57	1,025	175	1,200	1,125	− 75
1957–58	1,095	188	1,283	1,205	− 78
1958–59	1,165	187	1,352	1,280	− 72
1959–60	1,210	186	1,396	1,365	− 31

prospective foreign exchange transactions of the private sector of the economy.

Finally, Table III-13 presents estimates of the change in the privately held money supply due to the combination of government and import-export transactions, together with related data. The table ignores the effects of commercial bank loan contraction or expansion, since they are apt to be small.

The money supply in the hands of the public in 1952–53 is equal to 16·3% of the value of the nation's output. The table indicates a minimum increase in this percentage to 19·5% in 1955–56 and a maximum increase to 22·2% in 1956–57. What can be said of the effect of these ratios?

Per capita income will rise rapidly during the next several years. As it does, people will find it desirable and possible to keep more money on hand, and an increased ratio of the money supply in private hands to the value of output is necessary to meet this desire. It is not possible at this time to forecast with confidence how great the increase should be. An increase in the ratio to 19·5% by 1955–56 would probably merely provide a desirable stimulus to output, whereas an increase to 22·2% by the following year might cause excessive spending and inflationary pressures.

These facts lead to a very important conclusion. An excessive increase in money supply could be prevented by increasing revenue rates so that a larger share of expenditures is covered by revenues; it might be prevented by allowing slight price rises in domestic goods to stimulate imports. If the increases in per capita income find their outlet in increased imports there will be little or no inflationary pressure. The tax increase may or may not be necessary. If the forecasts presented in this chapter are valid, and if non-capital expenditures are held within the limits indicated, it is entirely possible that Burma can carry out her entire development program without any increase in her present tax rates. But it is only possible, not certain. Revenues imposed by the present tax

TABLE III – 13

TREND IN THE MONEY SUPPLY IN THE HANDS OF THE PUBLIC

(*millions of kyats*)

Year	*Change Due to Government Domestic Transactions (from Table III-11)*	*Change Due to Foreign Exchange Transactions (from Table III-12)*	*Total Change during the Year*	*Total Money Supply in Hands of the Public*		*Gross Domestic Product*	*Per cent of Money Supply of Gross Domestic Product*
				End of Year	*Average during Year*		
1952–53	120	+110	200*	859	759	4,650	16·3
1953–54	123–173	− 9	114–164	973–1,023	916– 941	5,200	17·6–18·1
1954–55	184–234	− 42	142–192	1,115–1,215	1,044–1,119	5,550	18·8–20·2
1955–56	170–220	− 86	84–134	1,199–1,349	1,157–1,282	5,950	19·5–21·6
1956–57	123–173	− 75	48– 98	1,247–1,447	1,223–1,398	6,300	19·4–22·2
1957–58	48– 98	− 78	(−30)–(+20)	1,217–1,467	1,232–1,457	6,600	18·7–22·1
1958–59	3– 53	− 72	(−69)–(−19)	1,148–1,448	1,183–1,458	6,800	17·4–21·4
1959–60	(−49)–(+1)	− 31	(−80)–(−30)	1,068–1,418	1,108–1,433	7,000	15·8–20·4

*Net decrease in commercial bank credit of K30 million is reflected in this figure.

system may prove not to be adequate, and to carry out the program without inflation it may be necessary for the Government to prepare in a year or two to stiffen its tax structure, presumably by raising the rates of some existing tax measures.

The indicated decline in the money supply in the hands of the public in the last years of the decade, as now projected, reflects a failure of capital formation expenditures within Burma in those years as projected to equal total government plus private saving within Burma during those years. This, if it occurred, would be deflationary. However, the precise trend of events five or six years in the future is so uncertain that it would be absurd to assume that the precise turn of developments now projected for that period has significance for future policy. If, for example, government projects are not executed as rapidly as now programmed, the pattern of expenditures from year to year will change even if the total for the seven-year period should not.

D. CONCLUSIONS

What is the significance of these forecasts?

The first fact which must be noted in assessing their significance is the margin of uncertainty in them. They assume certain things about the future and forecast others. They assume that the development program will be carried out as scheduled. They also assume that current government expenditures will be held to K700 million per year. They forecast the amount by which government revenues will increase under present revenue laws. They forecast also the value of exports, the value of imports and other foreign exchange payments, and the level of saving by firms and individuals as income rises.

The actual magnitude of all the data which are assumed or forecast may differ appreciably from the estimates presented. As a consequence, the conclusions drawn may require considerable modification as the development program progresses. In these circumstances, what is their usefulness?

(1) In general, they indicate the feasibility of allocating to the development program enough resources to carry it out. With regard to foreign exchange, they indicate that in spite of any probable future development, it will be possible to finance all foreign purchases necessary to carry out the development program. With regard to domestic expenditures, they indicate that the program is neither markedly too large nor markedly below the economic capacity of the country. No radical discrepancy exists between the magnitude of the program and the magnitude of the resources which will be available under present measures. New revenue measures or other fiscal measures may or may not be necessary to obtain sufficient reserves to finance the program. If they are, only moderate changes in present measures will be necessary.

(2) The forecasts indicate that for the immediate future the problem is one of organizing with maximum speed the administration and management of sound development projects. There need be no financial limitations on immediate expansion of the development program.

(3) The forecasts indicate the nature of the conditions and trends which must be watched. A development program as comprehensive as the one on which Burma is now entering requires equally comprehensive planning of economic policies. If such comprehensive policy planning is to be performed intelligently, it must be based on analysis not merely of the Government's budget but of the factors which are discussed in the present chapter.

While future trends are not fully certain, they are sufficiently clear to indicate the policy measures which must be taken now and those which must be planned for adoption if necessary. Chapter IV deals specifically with these questions of central economic policy.

CHAPTER IV

CENTRAL ECONOMIC POLICIES FOR THE PROGRAM

A. INTRODUCTION

The successful implementation of the development plan will not depend wholly upon sound design of individual projects and programs and effective arrangements for their execution and operation. It will depend in considerable measure also on the formulation and execution of appropriate economic policies to facilitate the balanced expansion of economic activity. This chapter examines major policy issues in the fields of fiscal, banking and foreign exchange and foreign trade policy.

On the assumptions of no general world war, continued rapid improvement in civil order within Burma, and effective prosecution of the development program, the preceding chapter arrives at the following economic forecasts:

(1) Production in Burma will increase rapidly throughout the remainder of this decade—more rapidly during the first half of the period than thereafter.

(2) Burma's exports, especially of rice, will increase rapidly. Their value will probably be adequate to finance all imports and other expenditures abroad, even if restrictions on imports from non-dollar areas are completely removed.

(3) During the next one or two years there will continue to be slack and underemployment in the country in spite of increasing output. At some time thereafter, however, as output approaches the economy's capacity, the economy will probably become tight.

This third development merits further description. As security conditions continue to improve, additional workers will be able to return to cultivation and other village pursuits. This together with an expansion of governmental and private investment will gradually absorb underemployed workers. Shortages of some types of labor and of some materials will appear. If administrative problems and problems of technical and skilled personnel can be overcome, total developmental expenditures will reach a level which will bring fairly general tightness of supply of labor and of commodities. The process if it occurs will be gradual, with specific shortages and bottlenecks emerging in growing numbers. As shortages become common in many sectors of the economy, progress in solving particular problems will no longer be enough. The problem of *general* shortages must be met by measures which will curtail total expenditures in the country or divert them to expenditures abroad. The Government's revenue, expenditure, and banking policies must be altered to accomplish this effect.

Policies concerning foreign exchange and foreign trade which will be advantageous can be stated at this time, subject of course to modification if major unforeseen changes occur. The precise development of domestic conditions is sufficiently uncertain, however, that the situation must be reviewed from year to year, and policies modified if developing conditions warrant. Anti-deflationary policies should be vigorously prosecuted now. The timing of appropriate changes will depend in some degree upon price trends in Burma and abroad, but mainly on year-to-year trends in governmental expenditures (developmental and other), private capital expenditures, and the country's productive capacity.

This chapter discusses appropriate policies and the principles which must govern policy. Following a section outlining the improvement in information which is needed for effective policy control, succeeding sections discuss fiscal, tax, banking and foreign exchange and foreign trade policies.

B. IMPROVEMENT IN FISCAL INFORMATION

The annual budget document of the Union Government presents a (still somewhat imperfect) classification of budget expenditures into current and capital and a corresponding division of receipts. Appended Ways and Means Accounts trace in varying detail the sources and uses of all funds handled by government agencies. Supplementary tables detail the activities of important agencies. If the governments of the world were listed according to the degree of information conveyed in their annual budgets, Burma would certainly rank in the top third of the list. However, if Burma is to manage effectively as comprehensive a development program as she is now undertaking, she needs still better fiscal information to guide her policies.

1. A BUDGET INCLUDING ALL AGENCIES AND FUNDS

What is needed is not merely more or more-detailed information of the sort now presented, but a broader budget concept. Chapter III has noted that with the expansion and diversification in recent years of the functions of the Union Government, an increasing number of state enterprises and other government agencies operate outside the framework of the main budget accounts. As a result, the information conveyed in the budget concerning the effects of government financial operations upon the economic system is increasingly inadequate.

For analysis of the effects of its operations in stimulating or restraining incomes and expenditures in the economy as a whole, the Government must have an annual record which includes every government agency, and which shows on the one hand total receipts from the public by the treasury plus all government agencies in combination, and on the other hand the capital disbursements of all the government agencies. Receipts in these inclusive accounts must include any revenues of enterprises allocated to reserve accounts as well as net profits, so that the total net inflow of cash from the public to the enterprises is recorded. All cash receipts of miscellaneous "funds" or accounts will be included. Transfers of funds from the general government account to state boards or corporations, which are not disbursed to the public, will be stricken from the record of disbursements. They are red herrings; they appear to be disbursements of funds, but are not.

Such a record of cash flows between the public and all government agencies taken as a group, divided between expenditures and receipts at home and those abroad and classified to permit analysis of their nature and their probable trend, is known in modern fiscal accounting as a "cash consolidated budget." To guide her economic policies, Burma must develop such a set of accounts.

While the present Ways and Means Accounts in principle deal with all receipts and disbursements of money by all agencies, in fact the data presented are inadequate for analysis. In many cases a budgeted transfer of funds from the general government account to a state enterprise or corporation is treated as a cash outflow, without analysis of whether it will in fact be disbursed. For some agencies only capital transfers—loans or repayments—between the treasury and the agency are specifically recorded; cash receipts or disbursements from or to the public are lumped in a catch-all account, "other deposits." For some agencies, only the unanalyzed record of cash receipts or disbursements is recorded, without indication whether receipts are net profits or unspent allocations to reserve accounts, and whether disbursements are losses or disbursements for the purchase or construction of capital facilities.

2. FOREIGN EXCHANGE TRANSACTIONS

Further, the usefulness of the present budget for fiscal analysis is limited by the incomplete separation of payments abroad from other expenditures. Even within the main budget accounts, not all expenditures abroad are separated from total expenditures; only sterling expenditures are distinguished, other expenditures abroad being indistinguishable from disbursements within Burma. For agencies which operate outside the framework of the budget, no separation whatever between domestic and foreign transactions is made. Officials endeavoring to judge the nature of the Government's foreign exchange expenditures, and hence their probable magnitude in the future, are forced to resort to estimates and pieces of information obtained from individual agencies.

Present budget practice with regard to foreign exchange expenditures presumably derives from a time before the war when all foreign expenditures were made in sterling, and a record of sterling expenditures or an estimate of them for the coming year was in fact a record or estimate of all foreign exchange disbursements. In present circumstances the practice has little usefulness. The Ministry of Finance, recognizing the obsolete nature of present procedure, is arranging to obtain in future years from all agencies whose records appear in the main budget accounts a separation of foreign exchange and other expenditures. This will, however, not permit analysis of other agencies.

Estimates of past and prospective government financial operations which are incorporated in the tables of Chapter III are based upon a painstaking attempt to estimate data of the sort which would appear in a cash consolidated budget. Some of the estimates are undoubtedly in error because of inability to obtain accurate information; furthermore, it would not be feasible for the Government annually to go through this item-by-item process of obtaining information or estimates for this specific purpose. For the annual budgeting required, improved procedures must be established.

3. PROMPT BANKING REPORTING

Budget information, to be most useful, must be available much more promptly than has been the case in recent years. Even though the budget accounts are on a cash basis, so that accounts are presumably closed by each disbursing or receiving officer promptly at the end of each fiscal year, the delay in assembling the information is such that it has not been possible in recent years for the budget presented to Parliament each autumn to show the record of receipts and disbursements for the year which ended ten months earlier. The most recent information presented is that for the year which ended twenty-two months before the presentation of the budget document. The delay, originally caused by disturbance to normal procedures arising from war and insurrection, has persisted. The usefulness of the budget as an indication either of the financial position of the Government or of trends in receipts or expenditure items is thereby greatly impaired.

As in the case of foreign exchange transactions, the officials of the Ministry of Finance and Revenue and the Auditor-General are aware of the unsatisfactory nature of this delay in accounting, and are striving to obtain agency records for more recent periods. Unpublished accounts now available show a reasonably complete record of budget receipts and disbursements for the year which ended ten months ago; it is to be hoped that by next year the records will be in such shape that it will be feasible to publish in the annual budget document accounts for a period one year closer to the date of presentation than is now the case.

4. EXPENDITURE ESTIMATES AND EXPENDITURE AUTHORIZATIONS

Quite apart from the deficiency in scope and lack of timeliness of the budget accounts, they suffer from inaccurate estimating of each coming year's expenditures.

However ideal conceptually the budgeting framework might be, budget estimates for each coming year will not be an efficient guide to action unless they are roughly accurate. An exaggerated estimate of total budget expenditures for a coming year, for example by estimating expenditures which in fact can be accomplished only over two or three years, distorts the entire analysis of budget requirements and of the economic effects of the expenditure programs. Within the total decided on as feasible, excessive estimates by one agency, if incorporated at face value, force unnecessary cuts in the funds allocated elsewhere, may retard other programs, or may cause improper and harmful revenue action to meet an expenditure total which will in fact not occur. The narrower the margin becomes between production and capacity in the economy, the more important will be the margin of inaccuracy in budgeting.

In recent years, budgeting by the Union Government has contained large errors of estimate. This is not due merely to careless or reckless budgeting by the officials concerned. In part the errors are inevitable in a period of changing and especially of rapidly expanding programs of expenditure because estimates of rates of increase in connection with such changes are subject to large margins of error.

But in part the errors are due to the method of presenting the budgeting estimates: to the fact that the forecasts of expenditures for each project serve as the legal authorization for the expenditure. The budget estimate for each project for the coming year is at the same time the forecast of the amount of expenditure for which financing must be provided, and the legal ceiling on the amount which the agency may spend for the purpose.

So ingrained is this procedure in Burma (and in a number of other countries) that some Burmese officials with whom the matter has been discussed have found it difficult to visualize clearly that any other mode of presentation is possible. Actually a change would be simple to make, and would improve greatly the usefulness of the budget. The reason why the amount set as the legally permissible expenditure is often a bad estimate of the amount which will actually be spent is this:

When a new program of any size is initiated, it is literally impossible to estimate accurately how fast it can be implemented. If it is a capital project requiring complex engineering design, neither the time when the design can be obtained, nor the time required to obtain tenders for construction and to award a contract, nor the time for construction can be accurately estimated. The time required for receipt of equipment or materials obtainable only from abroad is subject to variations beyond the control of the procuring agency. Whether a given step in the procedure is completed and the next one begun two months before or one week after the end of the coming fiscal year cannot possibly be foretold, but may make a difference of one hundred per cent or one thousand per cent in the amount which can efficiently be expended during the year. If the project is one requiring only simple engineering work, some but by no means all of the uncertainties of timing are eliminated. Even if it merely requires rapid expansion of a staff of specialized workers, a wide range of uncertainty in the speed with which this can be done is inevitable.

In these circumstances, if the maximum possible progress is desirable, it is necessary and proper that the agency shall request, the government budget reflect, and Parliament grant, not merely the amount of funds which is the best single guess concerning the amount which will be spent, but the much larger amount which it may be possible to spend efficiently. If because of budget procedures this large amount then serves as the estimate of actual expenditures, and if there is a number of such expanding programs in the budget, the budget estimate of total expenditures will necessarily be considerably in excess of the total which expenditures will actually reach. The remedy is not to reduce each estimate to the level of the single best guess of actual expenditures. The result of this procedure would be that many projects will be held below the rate of progress which, as the facts later show, they could have attained. The possibility of a supplementary appropriation at the spring session of Parliament is not a solution to this problem, for if only a "most probable" estimate is presented, programs which develop favorably may be legally handicapped in making desirable expenditures and entering into contractual obligations for the balance of the year, long before the spring session of Parliament meets.

The most effective remedy for this situation is one which has been regarded as a startling departure from established practice by some persons in Burma with whom it has been discussed, but which in reality is quite simple. The budget estimates for the coming year for each expanding program should be presented in two columns. One would present the expenditure *authorization*, the other the expenditure *estimate*. The expenditure authorization would set the legal ceiling to the expenditure. The expenditure estimate would present the best single estimate of the probable expenditure during the year. The sum of the expenditure estimates would be the total for which financing is planned. The total of expenditure authorizations for a number of new projects or expanding programs might be greatly in excess of the total of the expenditure estimates. Though for any one project the expenditure estimate, like any forecast in the circumstances, may be considerably in error, the total of ten such expenditure estimates is almost certain to be far closer to the later actuals than the total of ten estimates under the present method, or the total of ten expenditure authorizations.

A capital budget whose expenditure authorization properly totaled K500 million might conceivably have expenditure estimates totaling only K350 million. The latter total could be expected to be a far better estimate of total budget expenditures; yet if any one of the authorizations were reduced, it might retard a program which could otherwise go ahead rapidly.

Until some change is adopted which accomplishes the effect of the proposal above (which is the method of budget presentation used by the Government of the United States), it will be necessary for the Ministry of National Planning and the Economic and Social Board, if they are to plan effectively, to disregard the estimate of expenditures formally presented in the annual budget, and to make their own more realistic estimates of expenditures during the year.

C. FISCAL POLICY: THE LEVEL OF CURRENT EXPENDITURES

The rise in defense expenditures in recent years has overshadowed other budget trends, but nondefense expenditures for current purposes have also been increasing steadily. Their rise has resulted from the expansion of government activity in general but especially from the expansion of government programs for social welfare.

Expenditures for capital formation by their nature terminate when the project is completed; but a current program, once enlarged, requires increased expenditures in every subsequent year. Further, small initial expenditure on a new current program may commit the Government to increasing expenditures in subsequent years to develop the program to its full scale. Thus the current expenditure budget may develop a momentum of its own if the future consequences are not fully analyzed when small-scale initiation of new programs is undertaken.

The current expenditure sector of the Union Government budget has acquired such momentum that its size in future years, unless controlled with a view to the later expenditures involved in programs introduced in any year, may threaten the successful execution of the development program.

The social welfare programs, justifiable though each is in its own right, call for thorough appraisal because of the tendency of each to expand in this way. Health, housing, labor and other welfare programs, in addition to having their own immediate merits and justifications, contribute to other developmental programs but also compete for finance and manpower with them. Healthier and better educated workers are more productive workers. Too great expenditure on a large supply of complex machinery at the expense of schools and hospitals may mean that healthy and trained people will not be available to run the machines. However, if the welfare programs are expanded to a size which forces curtailment of expenditures for the more direct increase in the nation's productivity, they may, paradoxically, depress the nation's standard of living by preventing the execution of other programs which would raise it. Better housing for one worker may mean poorer equipment for another; shorter hours for one may mean higher cost of products bought for the other, and so on. This element of choice and balance must always be present in decisions concerning welfare programs if the nation's long-run welfare is to be most effectively advanced.

The balance between current and capital expenditures, and among specific programs within the current and capital budgets, must be decided only after complete examination of each. It would be foolish to propose any specific ceiling as the absolute limit beyond which current expenditures must not go, and to which they may safely expand. Yet it is obvious from the analysis presented in Chapter III that if the development program is to be carried out fully, current expenditures will need to be restrained, or alternatively, revenue rates must be sharply increased in future years to finance the added expenditures. It is therefore suggested that to establish a point of departure for budget control, K450 million per year, or about K50 million above the budgeted 1952–53 total, should be regarded as a ceiling during the period of the development program for current expenditures other than for defense, and that any advance of budgeted expenditures beyond this amount should occasion increasingly rigorous examination of them. It is believed that non-defense current expenditures will not reach this level in 1953–54 even though it may be budgeted, but if not they may reach or exceed it in the following year.

The momentum of programs under way will be a major obstacle in budget control, if budget evaluation looks only one year in the future. In receiving each request for funds for any new project or any increase in expenditures, the Ministry of Finance and Revenue should require the submitting agency to supply an accompanying estimate of the required expenditures for the ensuing three years. This should be the initial step in projecting the entire current expenditure section of the budget three years in advance. In analyzing new programs, it should be remembered however that a new program may merit an increase, even at the cost of reducing an existing one. Not all of the savings which may seem necessary should be in new programs.

In holding down current budget expenditures, it must not be overlooked that some programs which appear in the current rather than developmental budget are in fact among the most vital to the success of economic development. Among these are programs for technical education, mass adult education, education in skills, and "extension" work. The Government Technical Institute, the Artisan Training Center, the Rehabilitation Brigade, the technical colleges of the University of Rangoon, programs for training abroad, and new training programs now being planned, are examples. Among such vital expenditures are also salary increases to attract the best skilled and administrative workers ; and programs to propagate improved methods in agriculture. It is believed that the rejection in recent years of proposals for pay increase for workers with selected skills in Government, and for administrators at the higher levels, will retard the development program. It is believed also that the refusal in recent years to grant budget funds for pay increases and for expansion of staff in the extension service of the Department of Agriculture is a grave economic error. Very few other developmental expenditures of equal size will bring as large results in increasing the nation's standard of living as expenditures to increase the effectiveness of the agricultural extension service. This need is discussed at more length in Chapter VIII, Agriculture. These current items should receive high priority not merely in the current budget, but also priority above all but the most urgent capital items. To curtail these programs in order to finance capital projects might indeed be to gain the appearance of technological progress and lose the substance.

Capital projects as well as current programs require advance programming. A small initial expenditure for, say, a hydroelectric project may commit the Government to rapidly increasing sums during the three ensuing years. However, capital projects are apt to be thought of as units and the advance programming done as a matter of course, whereas with respect to current programs it may be overlooked.

D. FISCAL POLICY: THE LEVEL OF TAXATION

Tax rates should not now be increased. The possible desirability of increasing revenue rates at some time in the future should not lead to tax increases now, when the economy needs stimulus rather than restraint.

It is highly desirable, however, to establish a commission now to study the problem of the nature of tax increases when and if such increases become necessary. When, at a future date, developmental expenditures do reach the level at which further increases will run into limitation of labor force and productive capacity, choice must then be made between limiting these expenditures or increasing tax rates so as to reduce private spending. Policy decisions to increase taxes must be predicated on full understanding of the economic impacts and incidence of different types of taxes. Both incentives and restraints can result from changes in tax rates. It is not too early to begin to prepare a tax program which will be available for implementation as changes in fiscal impacts are needed.

Sale of government securities to the public should be considered as a supplement rather than as an alternative to additional taxation. Though every effort to sell such securities should be made, their availability is not apt to reduce private expenditures greatly and is therefore not apt to be an effective substitute for a tax increase as a means of reducing excessive spending.

E. THE STRUCTURE OF THE REVENUE SYSTEM

1. TAX POLICY VERSUS FISCAL POLICY

The foregoing section relating to fiscal policy has treated the problem of when to increase or to decrease the total tax burden. Quite apart from this question, there exists the question of the nature of the taxes which make up that burden. Is the best combination of taxes, and the best schedule for each tax, being used to obtain the necessary total revenue? This question will become more important at the stage of execution of the economic development program when resources are more fully used and the Government needs to gain the maximum results from its tax system.

The three most important characteristics of the tax system will be its equity, the degree to which it brings in added revenue as national income rises and more revenue is needed for the expanding development program, and the degree to which it stimulates or impairs the incentive to produce.

2. THE REVENUE SYSTEM, PREWAR AND POSTWAR

Table IV-1 presents revenue data for 1938–39 and 1951–52. The 1951–52 data, except for the profits of state enterprises, are revised budget estimates. They are believed to be approximately the actual receipts. It is important to note that the 1951–52 data include not merely budget receipts (both current and capital) but in addition total estimated profits of state enterprises. Whereas those profits are estimated at K370 million, only K210 million appeared in the budget as revenues, the remainder being retained by the agencies earning them. The data presented are thus more comprehensive in concept than budget revenue data and give a more accurate picture of the economic impact of revenues.

TABLE IV – 1

GOVERNMENTAL RECEIPTS, CLASSIFIED BY TYPE, AND INCLUDING ESTIMATED NET INCOME OF GOVERNMENTAL ENTERPRISES

Type of Revenue	*Millions of Kyats*		*Per cent of Total*	
	1938–39	*1951–52 (Rev. Est.)*	*1938–39*	*1951–52 (Rev. Est.)*
Land Revenue	54·2	21·5	33·0	2·6
Profits of State Enterprises (est.)	—	370·0	—	45·6
Customs	36·4	193·0	22·2	23·8
Excises and Excise Duties	23·0	34·8	14·0	4·3
Sales Tax	—	23·0	—	2·8
Taxes on Income	19·1	44·5	11·6	5·5
Other Taxes	5·7	24·1	3·4	3·0
Forest Revenue	14·3	13·0	8·7	1·6
Other Revenue	11·6	88·1*	7·1	10·8
Total	164·3	812·0	100·0	100·0
Gross Domestic Income	1,460	4,116		

*Excludes non-cash transfer of K30 million from the International Monetary Fund, matched by an equal non-cash payment to the Fund, the two together canceling out.

The major source of revenue at present is profit from state enterprises, predominantly profit from the State Agricultural Marketing Board on exports of rice. Together with land revenue, this made up almost 48% of total receipts in 1951–52. Commodity taxes —customs, excises, excise duties, and sales tax— yielded an added 31%. "Excise duties" is a term applied to all excises other than those on alcoholic beverages and dangerous drugs. Minor indirect taxes yielded 3%. In descending order of importance, these are state lottery, betting taxes, stamp taxes, entertainment tax, business premises tax, hotel and restaurant tax, motor vehicle taxes and document registration fees. Taxes on corporate and individual incomes produced between 5% and 6% of total receipts. Various non-tax revenues make up the remaining 12·4%. Chief among them are interest receipts on government loans, the gross revenues of the posts and telegraphs department and import license fees. Interest receipts are mainly an intra-governmental transfer, two thirds of the total consisting of interest on the loan to Burma Railways.

Two major changes in the tax system occurred during 1952 and 1953. One was abolition in 1952 of the turnover tax and substitution of a selective single-point sales tax collectible at import or point of production, with schedules of 5%, 10%, and 15% respectively on three schedules of covered goods. This change improves the equity of the tax as between different traders by eliminating the previous large-scale evasion, and also improves its equity as between different classes of buyers by introducing progressivity of rates. Basic "cost-of-living" goods are exempted altogether. Luxury goods bear the highest rates.

The other major change, which will be effective on October 1, 1953, is abolition of preferential tariff rates. This may not result in major change in the total burden of customs duties. Following notification in March, 1953, that preferential tariff agreements with Britain, India and Pakistan would be terminated effective on September 30, 1953, the Government has been considering the tariff rates to be adopted effective on October 1. The degree of preference which has been granted and the importance of the decision being made are demonstrated by a study of customs revenues for a recent three months' period, December, 1952, to February, 1953. The results are tabulated overleaf.

They indicate that revenues would have been increased by 42% if the present standard rates had been paid on the same imports, and decreased by 31% if the present preferential rates applying to the largest quantity of imports had been paid. The actual imposition of the rates indicated would of course not have produced these precise results, since the pattern of imports would have shifted, but the calculations show the importance of the decisions being made. Adoption of rates at intermediate levels might of course leave the average burden of customs at approximately the present level.

	(*K million*)	(*Per cent Change from Actual Revenue*)
Actual customs revenue	41·6	
Estimated revenue at prevailing standard rates	59·3	+42
Estimated revenue if all rates were reduced to the level of the preferential rate applying to the largest quantity of imports	28·6	−31

Less important tax changes were simplifications of the hotel and restaurant tax and abolition of the business premises tax, which had been adopted in 1949 as an emergency revenue measure.

3. THE REVENUE BURDEN, PREWAR AND POSTWAR

Total governmental receipts in 1951–52 were a considerably larger percentage of gross domestic product than in 1938–39. Profits from rice exports are properly to be regarded as in large part windfall gains at the expense of foreign buyers, resulting from the inflated world price of rice, which had risen to more than ten times the 1938–39 level, or more than twice the rise in the price level within Burma.

If paddy prices had been permitted to rise in the same ratio as the average of other prices, they would now be at say K450 per 100 baskets instead of K300. The profit margin on exports obtained by SAMB by holding paddy prices below this figure may be regarded as a tax burden; the remainder of its profits should be regarded as a windfall gain at foreign expense (though they are at the expense of cultivators or landowners in the sense that control of the price of paddy prevents the windfall from being passed on to them).

TABLE IV – 2

RATIO OF EACH TYPE OF REVENUE TO GROSS DOMESTIC INCOME 1938-39 and 1951-52

	1938–39	*1951–52*
Land Revenue	3·7	·5
Profits of all State Enterprises (est.)		
Total	0	9·0
Share regarded as tax burden (250)	0	6·0
Customs	2·5	4·6
Excises and Excise Duties	1·6	·8
Sales Tax	0	·6
Taxes on Income	1·3	1·0
Other Taxes	·4	·6
Forest Revenue	1·0	·3
Other Revenue	·8	2·1
Total Revenue, Adjusted*	11·3	16·5

*For 1951–52 includes only K250 million of SAMB profits, the share regarded as part of the tax burden.

On this basis about K250 million of the 1951–52 profits of SAMB should be regarded as a tax burden. Remaining profits may be regarded as windfall gain.

Table IV–2 indicates the composition or character of tax burden in 1938–39 and 1951–52 by showing the percentage which each type of revenue bore in each of the two years to the gross income of Burma. The gross domestic income was K1,460 million in 1938–39 and K4,116 million in 1951–2.

The data indicate that even on the adjusted basis the total tax burden in 1951–52 was about the same as in 1938–39. The greater postwar burden of customs, and of land revenue plus rice exports profits as against prewar land revenue alone, is offset only in part by the reduced burden of internal commodity taxes, income tax, and forest revenue. Miscellaneous revenue is also up sharply. The ratio of government receipts to the country's gross income will probably not decline as income rises. Land revenue is now only partially collected; its burden, though it will remain small, will increase as civil order is fully restored. When security permits revival of forest extraction, forest revenue will also rise sharply. The decline in income tax revenue as a percentage of aggregate income has occurred in spite of a stiff increase in income tax rate since prewar. It is probable both that enforcement is less effective now and that it can be improved. Income tax liability should rise relatively to national income as national income rises. As rice production and exports rise, rice exports profits allocable as part of the tax burden will probably be an appreciably higher percentage of national income than prewar, when output, income, and tax enforcement have become more normal. This is as it should be if the revenue system is to contribute appropriately to the financing of the development program.

4. EQUITY: PROGRESSIVENESS OF THE TAX SYSTEM

The revenue system cannot yield the necessary amount of total revenue without imposing burdens on all of the people. It is important that in doing so it bear most heavily on those most able to pay, i.e., that it be "progressive." The present system has a progressive nature, because of the income tax and the selective nature of commodity taxes, which cause them to bear most heavily on goods purchased by higher income groups.

Three postwar tax changes have tended to affect this progressivity, namely, the substitution of rice export profits for land revenue as the dominant revenue source, together with the imposition of legal limitation on the rates for agricultural land; the reduction in importance of excises and excise duties on widely used commodities and substitution of the graduated sales tax; and a sharp (and probably excessive) increase in the progressivity of income tax rates.

The influence of present paddy policy and rent restriction on the progressivity of the revenue system is mixed. In combination, their influence on the net income of cultivators and farm laborers, considered as groups, is about the same as the effect of prewar land rental and land revenue rates. While price control has reduced the return to the paddy grower, relative to other prices, a very large percentage reduction in rental costs brought about by rent restriction has reduced his expenses. The income of landowners has been reduced by rent restrictions to a fraction—in typical cases one sixth to one tenth—of its prewar purchasing power. Urban purchasers of rice benefit from the low rice price. Since before the war cultivators and agricultural laborers had the lowest income of the three groups and most landowners the highest, these changes reduce income differences between landowners and the other two groups but increase the difference between rural workers and cultivators on the one hand and urban workers on the other.

In the interest of equity between individuals and between groups, certain changes should be made in the tax laws. One example of such a change in the income tax is the substitution (if administrable) of allowances for wife (or husband), children and other dependents, in place of the present K3,500 minimum income rule.* Another example is change in the taxation of dividends. Company profits are subject to the company income tax; dividends are thereupon exempt from the personal income tax. They might better be taxed as personal income, with credit for tax paid by the company. This change would be feasible, however, only if the progressiveness of the upper-bracket individual income tax rates is reduced. These rates are discussed below in relation to the incentive to produce.

In the interest of equity between groups as well as of a rational tax structure, reconciliation of the present schedules of customs, sales, and excise taxes, and of licensing provisions should be undertaken. Present customs schedules are presumably based primarily on two considerations: ability to pay, with goods used mainly by higher income groups being dutiable at a higher rate; and admitting without heavy duty those items which enter into the cost of producing goods within Burma. (Other principles are of course applicable in specific cases.) The sales tax schedules are presumably based on the same principles, as are also decisions concerning the severity of license restrictions. Yet differentiations in sales rates between various goods are in a number of cases directly inconsistent with those in the customs schedules, tending to reverse and narrow the margin which the customs schedules establish, rather than reinforcing them. Again, in the cases of some goods taxed by customs and sales tax at low rates, because regarded as non-luxury items, import license restrictions so hold down the supply as to boost the domestic price sharply, thus being the equivalent of high protective customs or sales tax rates. However, the benefit accrues to the importer and not to the Government. Some excise duties on alcoholic beverages are heavier than the import duties on competing liquors. These various anomalies should be investigated and corrected in order that the indirect taxes as a group will impose a relative burden on various groups which is the planned and equitable result of those taxes as a group.

These comments present major examples rather than an exhaustive list of matters of equity which should be considered. The tax structure has been changed rapidly during postwar years. Various inconsistencies and inequities are bound to arise during such a period of change. A comprehensive study to eliminate them is advisable.

5. RESPONSE OF REVENUE TO INCREASE IN OUTPUT AND INCOME

It has been noted that governmental revenues must be increased as the development program gathers full speed. The greater the extent to which the revenue system automatically yields such an increase as output and income rise the less is the need for changes in revenues rates. In principle, Burma's revenue system scores well in this respect. Aggregate revenues from within Burma will probably rise somewhat faster than national income, as output increases. As noted above, land revenue will increase markedly as security improves. Forest revenue will increase with forest output, which is now very low. Revenue from customs, excises, excise duties and sales tax will very probably increase by a slightly greater percentage than national income. Purchases of consumer goods will probably rise at least as rapidly as national income, and in addition there may be some tendency with increasing per capita income to shift to the consumption of the less essential items bearing higher rates of customs or sales tax. Finally, income tax liabilities will undoubtedly increase considerably more sharply than does national income. As national income rises, the incomes of many individuals will rise, making them liable to higher rates of tax. Further, as national income rises many companies now making small profits will make increased profits and be liable to correspondingly increased income tax.

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*Though the tax schedule provides for taxation of all income above K600 per year, a separate provision designed to prevent hardship to low income individuals provides that no tax shall be paid unless the income is in excess of K3,500. The tax is identical regardless of number of dependents.

Whether these increased tax liabilities will be converted into increased revenues will however depend on the effectiveness of tax administration. It is clear that there is considerable evasion of income tax at present. To obtain maximum increased revenue as income rises, definite steps to improve income tax administration are desirable. There is no evidence of laxness on the part of present enforcement staff. But the job of enforcement requires a larger and better equipped and trained staff. The Report of the Income Tax Administration Advisory Committee presents sound recommendations for enlargement of the income tax enforcement staff, provision of vastly improved equipment and improvement in training procedures. These recommendations should be adopted in full. They can and probably will result in increased tax yields far in excess of their cost.

In addition, it is recommended that the services of one or more tax enforcement experts be obtained for a limited period. The problems of income tax enforcement in Burma and other undeveloped countries are more acute than those of countries with more elaborate accounting and other records, but they are of the same nature. It should be possible to obtain the services of one or more experts who are experienced in the methods which tax evaders have used in countries which have had high individual and corporate income tax rates for many years and with the requirements and procedures which have been devised to checkmate them. Such experts should be able to make valuable suggestions to Burma's income tax enforcement staff.

One feature of Burma's income tax which has met with some objection from taxpayers should by all means be retained in the interest of maximizing revenue as income rises, namely, the advance payment provision. Its abolition would in effect mean forgiveness of a large part of one year's taxes, in that from the date of its abolition, taxes would forever after be due one year later than otherwise. The advance payment provision is a valuable aid in obtaining complete payment under any system of stiff income taxation. It is especially desirable when income is rising, for the increasing income should be siphoned off as promptly as possible to have the maximum benefit in providing resources for a governmental development program. Further, it is relatively more enforceable. However, in fairness to those who are effectively taxed under this system, greater enforcement must be assured with respect to others who are not subject to the advance payment provision.

6. THE TAX SYSTEM AND INCENTIVE TO PRODUCE

The third important characteristic of a revenue system, in addition to equity and increase in revenue as income rises, is avoidance of interference with the incentive to produce. Burma's present income tax is not well designed in this respect. Various changes are needed.

One of these is related to the business profits tax. By this tax, which was introduced as an emergency revenue-raising measure, every individual, firm or company pays a tax of $16\frac{2}{3}\%$ of income arising as business profits, in addition to the other taxes on company or individual income. This provision is not in lieu of an allowance for earned income, i.e., income from personal services, for there is a separate allowance for that. It is an additional feature which sets profits off in contra-distinction to income from rents, interest on capital owned, and similar matters so that the man who uses his own funds in a productive venture retains one sixth less of the income from them than the man who acts as a money-lender or purchases property and rents its use to someone else. The law could hardly be more effectively devised to discourage productive ventures in favor of money-lending or landlordism. It should be repealed. If it is felt necessary to avoid a resulting loss of revenue, the rates of the individual or corporate income tax or of other taxes should be raised in compensation, thus leaving the total tax burden no greater, but eliminating the bias in favor of the rentier.

A second change desirable to increase incentive is to provide for the carry-forward of business losses in any year to any of the ensuing three or more years. By this provision, an individual, firm or company which sustains a loss in one year may subtract it from a profit in an ensuing year (within the term of years specified) in calculating its taxable profit for each year. For example, under present law a company which sustains a loss of K10,000 in one year and gains a profit of K10,000 in the next year must pay K5,000 tax on the profit, thus paying K5,000 in income tax even though its net income combined is zero and, in fact, on an after-tax basis, it suffers a loss. If carry-forward of loss were permitted, the company might subtract the K10,000 loss from the K10,000 profit and pay no tax. Such a provision, which permits a company or individual or firm to pay tax on its true net income over a period of years, rather than on each year's record separately, is especially valuable for new businesses, since losses are often to be expected during the first years of a business venture, and the right to set them off against possible later profits will be one of the determinants in deciding initially whether to undertake the venture.

A third desirable change is reduction in the progressiveness of the upper brackets of the income tax on individuals.

Any new employment-creating venture involves risks; if the tax schedule provides a scale of rates which rises too sharply, the increase in income which may be retained if increased income is earned is not worth the additional risk, and the venture is discouraged.

This feature of a progressive income tax must always be balanced against the prime advantage and reason for progressivity, namely heavier taxation where there is greater ability to pay, for the sake of equity. The balance of rates which is held to place no intolerable bar in the way of incentive, while yet yielding equity, must be decided by each society in the light of its own standards of income and reasonable goals of personal attainment and its own need for productive enterprise.

The present ordinary plus super-tax rates on individuals or unincorporated firms in Burma rise so sharply that they seriously reduce incentive. Modification of them may increase rather than reduce tax revenue. Yields in the upper brackets of the income tax are in any case rather small, because of the relatively few individuals who have sufficient income to be liable to the upper-bracket rates; and modification which increased the incentive to increase income might enlarge aggregate yields or at worst leave them unchanged.

Most persons in upper income brackets undoubtedly avoid the heavy upper-bracket tax rates by incorporating their businesses and receiving their income in the form of dividends, which are not subject to the individual income tax. Only if the upper-bracket rates are rendered much less progressive should the present treatment of dividends be altered. The two changes in combination would improve the equity of the tax system without unduly impairing its effect on incentives.

7. RE-APPRAISAL OF THE TAX STRUCTURE

The various suggestions made above for study of the tax system relate to two different purposes: (1) Determination of the most desirable method of increasing total revenues, if the need for more revenue develops, and (2) improving the internal structure of the tax system, the various rate schedules and the relationship of various taxes to each other. It is recommended that an intensive and comprehensive analysis of both questions be undertaken. After proper tax principles have been formulated, specific tax measures should be spelled out. Top technical assistance should be secured for the study.

F. BANKING POLICY

1. IMPORTANCE OF THE COMMERCIAL BANKING SYSTEM

Credit expansion in Burma through the monetization of foreign exchange or through the sale of government or government-guaranteed securities to the Union Bank of Burma will be regulated, not by banking policies, but by decisions concerning fiscal policy. Banking policies as such will, however, limit the third source of credit expansion, that by commercial banks.

The consolidated balance sheet below indicates selected assets and liabilities, on December 26, 1952, of the 23 commercial banks then in operation in Burma.

TABLE IV – 3

CONSOLIDATED BALANCE SHEETS, COMMERCIAL BANKS, DECEMBER 26, 1952, SELECTED ITEMS

(*kyats*)

Liabilities	
Deposits—Total	29,25,81,717
Demand—Total	24,36,63,677
Inter-bank	2,30,51,122
Other	22,06,12,555
Time—Total	4,89,18,040
Inter-bank	28,644
Other	4,88,89,396
Assets	
Cash—Total	85,88,471
Notes	85,59,665
Coins	28,806
Balance with Union Bank	
Head Office	6,80,21,957
Branches and Treasury Agencies	26,60,026
Advances	14,62,96,175
Bills	45,15,714
Investments—Total	3,60,54,874
Government and government-guaranteed securities	2,51,78,098
Other	1,08,76,776

Their deposits constituted 35% of the money in circulation. Of their cash and earning assets 57·7% consisted of loans and advances, practically all payable on demand; only 9·5% consisted of government securities, and only 4·1% of other securities. The bulk of their loans and advances relate to import or export trade and are typically secured either by foreign trade documents or by stocks of goods which are under lock and under guard in warehouses owned or controlled by the banks.

Since the date of this balance sheet, one added bank has been chartered. Of the 24 banks in existence at the end of June, 1953, 13 are branches of foreign banks; only 6 small ones are owned by Burmese nationals. Thirty-one banking offices are maintained by these banks; 22 are in Rangoon, 5 in other seaboard towns (Moulmein, Akyab and Tavoy) and 4 inland (in Mandalay, Maymyo and Taunggyi).

In any country, the part which commercial banks can properly play in financing economic development is limited by the fact that they cannot appropriately purchase either shares or industrial bonds and that their lending resources are of necessity limited. Because of the location, ownership and interest of the commercial banks of Burma, and because of the absence of developed credit institutions in the country in general, the present commercial banks of Burma will play an even smaller part during the coming decade in financing the country's economic development than may be the case in some other undeveloped countries, and would be the case in more developed countries.

Yet credit creation by the commercial banks can be large enough so that its regulation will be of importance. Table IV–4 indicates the advances and bills discounted by commercial banks at the annual high and low points since January, 1948. During the five-year period, the peak amount of loans and advances increased by 160%.

TABLE IV – 4

COMMERCIAL BANK BILLS AND ADVANCES, ANNUAL HIGH AND LOW POINTS, FEBRUARY 1948 to JUNE 1953

(millions of kyats)

End of	*Advances plus Bills Discounted*
February, 1948	81·3
November, 1948	51·1
January, 1949	86·9
November, 1949	44·5
April, 1950	117·6
October, 1950	88·1
February, 1951	179·9
September, 1951	135·8
February, 1952	203·3
October, 1952	130·1
January, 1953	211·1
June, 1953	130·2*

*Most recent date available. Probably not the seasonal low, which usually occurs later in the year.

There is some evidence that the February, 1952, peak would have been higher if the banks had had greater financial resources. The central banking legislation in effect at the time made it impossible for the Union Bank to extend credit to the commercial banks. In June, 1953, bills and advances outstanding were only K1 million above the 1952 low level; it may fall much below it during the autumn months, because of the increased amount of money injected into circulation during the year by government disbursements and SAMB rice purchases.

2. CENTRAL BANK CREDIT CONTROL

The changes illustrate the large credit swings which might occur in the future, if not regulated. It is important that the expansion or contraction of commercial bank credit be regulated, so that it will reinforce rather than counteract governmental policies designed to coordinate economic activity of the country during the development program.

Under the 1952 Act, the Union Bank of Burma has adequate power both to regulate and to assist the commercial banks of the country. Its power of control over foreign exchange transactions, and the power granted in the 1952 Act to fix the share of the assets of a Burmese branch of a foreign bank which must be employed in Burma, give the Union Bank as effective control over a branch as over an indigenous bank. The high level of competence of Union Bank management to date suggests that credit regulation will be effectively carried out.

For the control of credit expansion, the fundamental regulatory power can best be exercised by varying from time to time the reserve which scheduled banks must keep on deposit in the Union Bank. At the present time, the requirement is set at 8% of the demand deposits liabilities plus 3% of the time deposits of each scheduled bank. These low reserve requirements make it possible for the commercial banks to extend additional loans at their discretion. This is the appropriate policy for a period of economic slackness. Unfortunately, the Union Bank can only set the stage for such credit expansion; its action may be completely ineffective in terms of precipitating credit expansion.

On the other hand, Union Bank restriction on commercial bank credit can be an absolute bar to undue expansion. At a later date, if tightness appears in the economy, it will be appropriate to increase reserve requirements. A moderate increase can retard the rate of increase by commercial banks in their loans and advances; a greater increase in reserve requirements can completely check loan expansion, or even in the extreme case force reduction in the volume of loans outstanding.

Loan expansion results in corresponding increase in the money supply in circulation; restriction of it, by restricting private business expenditures, can check the demand for labor and commodities and so prevent scarcities and inflationary pressures. Stated in another way, preventing loan expansion by commercial banks would limit private investment expenditures to the sums which can be obtained from current saving plus advances, if any, from governmental development corporations. By thus restricting the funds available for private investment, it would permit the execution of a larger public development program. This would not impose a severe restriction on private investment, for there is evidence that the firms of Burma save a considerable portion of their current income. These savings would be available for investment. Of course even this moderate degree of restriction may be undesirable. Commercial bank credit expansion, by facilitating an increased rate of private investment, will reduce the volume which the government must undertake to reach a given total goal. This may be the desirable policy. The appropriate agencies will have to formulate, in the light of circumstances and prospects at the time, projections of the appropriate volume of governmental and private investment respectively, and to recommend budget and banking policies consistent with this program. Through its relationship with the Ministry of Finance and Revenue and its representation on the Economic and Social Board, the Union Bank will share in such a decision.

In the past, funds to handle seasonal needs for increased credit have been provided in part by Burma branches of foreign banks by drawing on their home offices. Seasonal flexibility of the money supply is important, as Table IV–4 indicates, and inflow of funds from abroad to meet seasonal needs should be encouraged. To permit it without permitting other credit expansion, if the occasion should arise, will require skillful regulation. Some flexibility in foreign exchange rates, rather than direct quantitative control of the import of funds, may be desirable. The rigid relationship to the pound sterling which has prevailed in the past may not be desirable when foreign exchange regulation becomes a necessary part of domestic credit control.

The following paragraphs present the background significance, and desirable sources of action relating to the provision of adequate loan facilities in villages and rural communities.

3. VILLAGE FINANCE

The fact that the branches of large foreign banks in Rangoon are commonly known as " exchange banks " is testimony to the extent to which they have concentrated on the financing of foreign trade. In addition to the financing of exports and imports, their business has consisted mainly in lending to the large foreign-owned companies engaged in the extraction of minerals or timber and in the 1920s in lending to the Chettyars. The Chettyars, in turn, using primarily their own capital but also some borrowed funds, financed agriculture, but not adequately. In considerable parts the business of the commercial banks has resembled a large-scale pawnshop business, in which they made loans against the physical possession of actual stocks, keeping the stocks under lock and key until the loans were repaid. Making crop or consumption loans to Burmese agriculturists or loans for current purposes to small indigenous industry would have required close supervision in the field and a knowledge of Burmese practices and enterprises which the banks were unable to acquire, or felt it unprofitable to acquire. With very few exceptions, notably Dawson's bank, the large western-type banks had no desire to enter this loan market.

The absence of commercial banks in most of the smaller cities and towns of Burma has undoubtedly a number of other causes: lack of capital among Burmese nationals and lack of the experience necessary to operate a commercial bank successfully; the great profitability of using one's capital for personal lending, as in sabape loans; the limited volume of potential banking business in smaller towns; lack of public acquaintance with commercial banking facilities and their advantages, as a result of which banking would perhaps not quickly have been profitable even in communities whose volume of business might seem on the surface to justify the establishment of a commercial bank.

The scarcity of capital in the villages at reasonable loan rates has created a vicious circle which has made it extremely difficult to improve agricultural practices, even if the necessary knowledge and incentive existed, and extremely difficult for an enterprising individual to climb the ladder from agricultural worker to renter to landowner. So rapidly does a debt increase, once usurious interest rates begin to be compounded, that one mishap such as the death of a yoke of oxen may start a landowner on an almost certain road to the loss of his land.

The absence of credit facilities and available capital has hampered the growth of indigenous industry and trade, both by preventing the increased use of a system of checks and other credit instruments and, more important, by depriving local businesses access to credit in necessary amounts and at reasonable interest rates. Because agriculture dominates the economy of Burma, it is obvious that conditions in the agricultural loan market determine the conditions in the market for loans to indigenous traders and small industry as well. Adequate organized sources of long-term or short-term capital loans for trade and small industry do not exist. The same exorbitant interest rates have interposed an often insuperable barrier to entry into operation or the expansion of a trading enterprise or a small industrial venture, even though the enterprise was sound under conditions of reasonable loan rates. Even the sabape loans have their counterpart in trade loans to cottage industries. For example, it

TABLE IV – 5

GOVERNMENT LOANS TO SMALL-SCALE INDUSTRY

(*kyats*)

	1947–48	*1948–49*	*1949–50*	*1950–51*	*1951–52*	*1952–53*	*1953–54*
			Loans to Weavers				
Loans							
Budget Estimates	6,00,000	6,00,000	5,00,000	5,00,000	5,00,000	7,50,000	7,50,000
Actuals	1,96,074	1,16,324	2,85,112	5,01,424	4,11,846	3,00,000†	—
Repayments							
Budget Estimates	5,99,000	5,91,000	1,00,000	4,00,000	3,00,000	4,00,000	5,00,000
Actuals	3,12,044	58,246	52,509	1,00,569	2,19,230*	3,00,000†	—
			Industrial Loans				
Loans							
Budget Estimates	5,00,000	4,99,500	2,50,000	2,50,000	3,00,000	13,00,000	10,00,000
Actuals	1,30,154	80,650	25,705	51,372	82,434*	5,00,000†	—
Repayments							
Budget Estimates	nil	30,000	1,00,000	1,00,310	1,00,000	1,61,000	5,00,000
Actuals	6,963	6,476	16,825	35,049	33,361	60,000†	—

*May be somewhat modified by supplementary figures.

†Revised estimates, not actuals.

appears common for merchants to make short-term loans to weavers in return for pledges to sell all output to the lender at prices so much below current market prices that the gain is equivalent to an interest rate of 400–600% per annum.

The Government has endeavored to alleviate somewhat the shortage of capital not only by the loans to agriculturists discussed in Chapter VIII but also by loans to small-scale industry. Government loans to small-scale industry in recent years are shown in Table IV–5.

Additional loans are made to non-agricultural cooperative societies, but these are primarily to consumer cooperatives and to cooperatives concerned with marketing and basic processing of agricultural products. In total, they were about equal to industrial loans for the period 1947–48 to 1950–51; thereafter they were radically increased. In 1952–53, the revised budget allocation for such loans was K7·5 million. Preliminary figures indicate that about K1 million was issued to small-scale industrial cooperatives.

Even if the total allocations of all types of loans to small-scale industry in 1952–53 materialize into actual loans, they would represent only a few kyats per worker per year. Budget allocations, however, are not all being converted into actual loans. This is shown by the figures in Table IV–5. Only 30% of government allocations materialized into loans over the five-year period, 1947–48 to 1951–52, for which data on actual loans made are available. The rate for loans to non-agricultural cooperative societies was even lower up to 1951–52, in which year large loans, only a small amount of which probably went to small-scale industry, raised the five-year ratio of actuals to allotments to 65%.

Loans to weavers are administered by the Office of the Superintendent of Cottage Industries, and industrial loans are administered by the Board of State Aid to Industries, both of which agencies fall under the Directorate of Industries. (Loans to non-agricultural cooperative societies are administered by the Cooperative Societies Department and are mostly channeled through district cooperative societies; their distribution is a matter of cooperative organization and is not considered in this chapter.) Actual loan operations follow a complex procedure in which final action is taken within the channels of ordinary civil administration.

The problem of which the separate pieces have been discussed in preceding paragraphs is not four problems, one in agriculture, one in industry, one in trade and one in personal finance. It is rather one problem, the problem of village finance. Personal loans, for example, cannot be separated from production loans in agriculture or industry or trade. The process of living until harvest, or until goods are sold, is a part of the process of production. Denying credit for prudent personal loans would merely drive the borrowers to usurious sources which would create a heavy drain on family income and might threaten the soundness of production loans.

Legal prohibition of usurious interest rates will not alone meet the problem; the high rates result from shortage of capital. As long as the shortage exists, there will still not be enough funds available to meet all needs. Lower interest rates will of course result in larger demands for loans. Indigenous enterprises can be furnished adequate finance only if enough capital can be supplied to meet all prudent demands for loans which will appear when money is available at the lower rates.

As the development program progresses the level of economic activity will increase and a larger share of it will become industrial or commercial. It will be imperative that commercial banking expand in scope, to play its full part in the development. However, it would be undesirable to establish commercial banks in interior towns before business activity and methods justify them. Failure of banks because of premature establishment would retard the further development of banking. On the other hand, the development of banking will expedite economic development. If private capital does not come forward to establish commercial banks when and where their need is manifest, the Government should carefully consider the problem involved in the establishment by it of commercial banks in one or more centers.

Commercial banks will not however fully solve the problem of village finance, since by their nature they can operate efficiently only in the larger towns.

The State Agricultural Bank which has been recently established by the Government can solve a large part of this problem. The program calls for establishment in each village of a locally managed village bank to make crop loans on the signature of three cultivators, to provide the financial basis for multi-purpose cooperatives, and in other ways to promote village welfare. The village banks would be supervised by branches of the State Agricultural Bank located in the districts, which would provide funds and which would directly administer intermediate term loans and loans to cooperatives. During 1953, branches have been established in four districts and about fifty village banks have been organized. With the experience gained this year the Government can gradually extend the banks' operation to other areas.

If these banks are to contribute most effectively to raising the standards of village production and living, each village bank must develop as the heart of a multi-purpose village cooperative movement, in which villagers actively participate and whose purposes as an accumulator and distributor of savings they understand. If the village banks operate simply as government loan agencies, they may serve a useful purpose in financing production, but they will not serve with full effectiveness in integrating and energizing village life and their "easy money" aspect may lead to the same mismanagement which brought disaster to the prewar cooperative banking system. Consequently, the system of village banks should be extended only as cooperative society members and administrative officials can be trained in the responsibilities involved in operating them, even if this precaution involves delay in the expansion of the system.

Until the time when banks are established throughout the country facilities for issuing direct government loans will continue to be necessary. Present plans for the State Agricultural Bank provide for loans to village cooperatives by the Bank from its own funds, where cooperatives are organized; and for administration by the bank of direct loans to cultivators from government funds, where cooperatives do not exist. This administration will consist only of disbursement of funds to local civil administrative officials, who will make individual loans and collect repayments. Where multi-purpose village cooperatives exist, they may extend loans to small-scale industry and other local borrowers on a cooperative basis, receiving the necessary funds from the Bank; but is it not intended that the Bank shall administer direct loans to non-cultivators where cooperatives do not exist. Indeed, where the loans are disbursed by special officials, as for example by the supervisors of loans to weavers, there is little point in interposing the Bank into the mechanism.

It is desirable that over-all credit policy continue to be formulated at the top levels of administration generally responsible for fostering small-scale industry. But individual loan transactions should be made in the local community through personal contact. A system which requires correspondence and the filling in of long forms will never reach the small commercially unsophisticated producer. Moreover, experience in other countries shows that personal contact offers a valuable opportunity for counseling the borrower concerning the operation of his enterprise. However, a loan office cannot be established in every community where credit is needed. The operation of a small-loan system is costly. For example, the supervisors of loans to weavers, on the average, handle less than K20,000 of loans each annually. The best solution to this problem is three-fold: (1) The Directorate of Industry should send out mobile units in areas, not served by multi-purpose village cooperatives, in which the anticipated volume of business is sufficient to justify the expense. (2) Isolated cases should be handled by the regular officials of the civil administration who now handle direct agricultural loans. In these cases the branch of the State Agricultural Bank could administer the loans in the same sense as it administers direct loans to cultivators. (3) Loans to non-cultivators should be made by multi-purpose village cooperatives, as soon as village banks can be developed on a sound basis.

Another basic feature of the loan system should be that it in fact deals in loans, not subsidies, i.e., it must insure that loans are repaid. As indicated in Table IV-5, repayments in the five years 1947–48 to 1951–52 have been only between a fourth and a half of the volume of loans. The rate of interest charged should be very low. As part of the over-all program of reducing interest rates in Burma, this will not subsidize one sector of enterprise as against another, but will serve to stimulate activity throughout the economy. However, the repayment provisions must be strictly enforced, otherwise, in effect, the defaulters are being subsidized. Indiscriminate subsidization resulting from lax repayment provisions is economically capricious and is more apt to be harmful than to be beneficial. It undermines public morale and morality. The decentralized local and personal loan system recommended above would facilitate debt collection and thereby tend to avoid these evils.

While the State Agricultural Bank and the direct loan program can be expected to meet much of the need for production credit, facilities for small single-signature consumer loans will also be required. Existing pawnshops operate at high interest rates and often do not have adequate facilities for storing pawned articles. A mission has returned from Indonesia where it studied the system of state pawnshops which has proved so successful in meeting small loan requirements. A state pawnshop has subsequently been opened in Insein and personnel are being trained for a second shop to be opened in Rangoon in 1953–54. Additional pawnshops are planned in subsequent years as personnel are trained. One important development is that borrowers will share in the profits of the pawnshop. The government program for opening pawnshops can probably be accelerated if the experience of the Insein pawnshops proves to be successful. So far it appears that the scheme is progressing favorably.

These programs for increasing the amount of credit available at reasonable rates cannot be considered to be a complete remedy for the financing problems of cultivators and small industries. Many cultivators and operators of small industries appear to have encountered financial difficulties because of an inadequate understanding of the role of credit in production and the need for accumulating savings. Current savings are often spent without sufficient regard for future financing requirements. An unexpected mishap or sickness usually causes serious financial difficulties. At present, however, there are no facilities for saving in the village other than investment in gold and jewelry. The savings departments of commercial banks are available in only very limited areas and even the facilities for postal savings are limited to the township headquarters. Gold and jewelry have the benefit of prestige as well as being easily hidden and being safe from deterioration. To substitute the idea that a paper document in one's possession or in the safekeeping of a bank or cooperative is more desirable will take a long time. Yet a country as urgently in need of capital for development as Burma must utilize every possible avenue for increasing the country's domestic savings and every means for channeling these savings into productive channels. For this reason educational campaigns should be instituted and administrative improvements sought after to popularize the increased use of savings departments of commercial and village banks, of postal savings banks and similar institutions, and the use of cooperative societies for the purpose of saving as well as a place to obtain loans. State pawnshops, too, should be so managed as to develop into institutions for the safekeeping of valuables and later as savings institutions rather than mere loan offices.

G. FOREIGN EXCHANGE AND FOREIGN TRADE POLICY

1. FOREIGN EXCHANGE CONTROLS, GENERAL CONSIDERATION

The basis for Burma's policy concerning foreign exchange controls should be the fact that foreign exchange will probably be plentiful even at the height of the development program. The implications are far-reaching.

(a) Whereas continued watch should be kept on foreign exchange trends, there is no reason to plan now for periodic tightening or loosening of foreign exchange and foreign trade restrictions. Instead stable policies may be planned with the expectation that they will be appropriate throughout the decade.

(b) There is no reason why Burma should construct a productive enterprise in Burma in order to save foreign exchange. Some countries must establish uneconomic enterprises at home because they cannot afford to buy abroad. Burma need not produce any item at home which she can more advantageously buy abroad. Unless non-economic considerations require production in Burma even at the cost of an economic loss, Burma can select for execution in Burma only those projects which will raise her standard of living.

(c) Since domestic resources are much more apt to become scarce than is foreign exchange, in her advance planning Burma should plan to purchase as large a share of the materials for her development program abroad as is economic.

(d) If bottlenecks and scarcities appear in Burma, the Government should encourage the residents of the country to spend abroad rather than here, by minimizing the restrictions on obtaining foreign exchange. One way to do so would be to liberalize the rules concerning remittances abroad. Raising the share of income which may be remitted abroad monthly, and the absolute limit on such remittances, and relaxing foreign exchange regulations concerning expenditures during travel abroad are examples of desirable changes. The principle that it is good, not bad, for Burma to have her residents exchange kyats for foreign currency should become a principle of action.

This does not carry any implication concerning the export of capital. The quantities involved may be too large even for sizable annual net receipts of foreign exchange to cover. Permission to export capital, if it is to be granted, should initially be granted on a restricted and experimental basis and in successive steps, until by trial and error the amount of capital which may wish to fly is roughly determined.

A possible corrective to an excess of domestic spending is a slight increase in domestic prices, which of itself will cause some shift to increased imports, as has been suggested in Chapter III. However, the degree to which this shift would occur can easily be exaggerated, and it would be dangerous to assume that a slight price rise will bring on automatic corrective action.

(e) The desirability of freeing foreign exchange expenditures does not imply the desirability of reducing the cost of foreign goods through tariff reduction. What will be wanted, if resources in Burma become scarce, will not be the maximum physical volume of imports but the maximum expenditure for them, to drain as much purchasing power as possible from the Burmese economy. Expenditure may be maximized by high rather than low tariffs. Considerations such as this, plus the question whether the time has arrived to siphon income away from Burma, plus considerations of the effects on the cost of living and the cost of production in Burma, should govern changes in tariff rates at any given time.

Even though Burma's prospective foreign exchange earnings continue to be plentiful, foreign exchange should not be wasted. Foreign exchange is not sterile; it can be invested abroad to earn income which will raise the future living standards of the country.

2. FOREIGN TRADE POLICY

It does not necessarily follow from the prospective ample supply of foreign exchange that Burma should free all imports from controls. Import restriction is urged for two reasons not connected with foreign saving; to protect infant industries in Burma and to foster the Burmanization of import trade.

3. INFANT INDUSTRIES

Temporary protection is clearly desirable for industries which cannot otherwise gain a foothold and which when they have gained a foothold will be able to produce as efficiently as abroad. However, there are alternative methods of granting protection. The use of a protective tariff is normally more advantageous than a licensing system. With a tariff in effect, both traders and domestic producers know that no added supply can be brought into Burma at a cost below the export country's price plus freight and other costs, plus the tariff. They also know that an unlimited amount can be brought in at that price. Consequently, the domestic price will be stable, at or near the cost level.

Both the infant industry and the consumer are protected from fluctuations, whereas under a licensing system the price may vary depending on the accuracy with which the licensing authorities estimate the appropriate amount of imports to be authorized. Limitation of imports by license provides a windfall gain to the lucky recipients of licenses; a protective tariff obtains this increment for the Government. Finally under a licensing system there is always the possibility of deliberate abuse of personal discretion by licensing authorities; use of a protective tariff eliminates this risk. For these reasons, it is recommended that tariff protection be adopted rather than direct quantitative restriction of imports, where protection of infant Burmese industries is deemed desirable.

In some cases, a temporary subsidy to the domestic industry might be preferable to restriction of imports by either quota or tariff. Whatever method is determined upon, an essential requirement for effective stimulus of new industry is that the policy be known and dependable so that trade and production can adjust to it and be conducted efficiently. Import licensing can never be as dependable as a tariff schedule or an announced subsidy schedule.

4. BURMANIZATION OF FOREIGN TRADE

The question of use of a licensing system to foster the wider participation of Burmese nationals in the import trading business is more complex. A subsidy system is ill adapted to the purpose, and a tariff is of no use whatever, since it gives no advantage to indigenous firms. An import licensing system, with a generous share of import licenses available only to Burmese nationals, was adopted by the Government.

It is of course true that an import licensing system is subject to great abuse. The granting of licenses without investigation to wholly unqualified persons provided only that they were Burmese nationals, when licensing was first undertaken, the open sale of these licenses to foreign trading firms, the accompanying favoritism and sometimes corruption, the maintenance of exorbitant profit margins on scarce commodities—these things are commonly acknowledged.

These may be said to be imperfections of a system in its infancy, which have since been corrected. By the present time, the majority of imports are under "Open General License," which permits import without license. Although the licensing process has not functioned as smoothly and flexibly as is desirable, licenses for the import of many other goods are generally granted rather freely, so that exorbitant profit margins are far less common. Procedures for the investigation of applicants for licenses have been established. Favoritism, corruption, and the sale of licenses have been greatly reduced.

Certain difficulties remain. The evils referred to above still prevail, though in smaller degree. It remains true that future import of every commodity is subject to the discretion of the licensing officials. Abuse of personal discretion is still possible. No importer has assurances that imports can be continued without interruption. There are often delays, even when licenses are finally obtained. When licenses are obtained, they lapse if not used within a specified time. Hence there are gluts of goods under license at some times and shortages at others, with resulting price fluctuation. There is always the danger that continued artificial protection will promote inefficiency. Such conditions are in some degree inherent in any licensing system and provide powerful arguments for the elimination of the system when it is no longer seriously needed. Under a free import arrangement, prices of imports would be more stable and on the average lower. The cost of living as a whole would be reduced somewhat, though this effect would probably not be great. There would be no incentives to hoard supplies and little opportunity for speculative gains.

Elimination of the present uncertainty concerning future imports would stimulate economic development. An enterprise using imported materials is dependent upon an uninterrupted supply. Any basis for skepticism on this matter causes hesitation in the establishment of new ventures.

Another advantage of freeing trade which is of peculiar importance to Burma at the present stage in her development is the freeing of administrative officials needed in the administration of licensing procedures. Any means by which Burma can economize on administrative talent will be to her advantage for it is her scarcest resource.

In spite of these difficulties, the continuation of import licensing may be desired because of its one important advantage. The system has been responsible for establishment in the import trading business of a number of Burmese-owned firms which would probably not otherwise have gained entry. The degree of protection furnished by the license quotas still in force is perhaps necessary to protect Burmese firms until they gain further experience, and is probably fostering continued growth in the number of Burmese nationals who are traders and also the volume of their business.

The facts are uncertain. It is recommended that an inquiry should be undertaken to ascertain how many recipients of licenses have actually established contacts with foreign suppliers, and how many merely buy through foreign firms established in Rangoon; how many do a wholesale or retail trade in Burma, and how many merely import and sell to nonrecipients of licenses; in what lines of business the establishment of Burmese nationals has been and is apt to be most successful; and many related facts and judgements.

Import licensing, if continued, should be administered in accordance with two main principles.

(a) Licenses should be granted for at least as large a volume of imports of each commodity as would enter under open general license, the only protective feature of licensing being the limitation of the quantity of licenses granted to non-nationals. The burden on the cost of living will thereby be minimized without removing protection to Burmese nationals. Liberal licensing to Burmese traders will render less profitable or less valuable the transferring of licenses to foreign traders. Wherever such transfers can be ferreted out, the penalties should be severe.

(b) As a supplement, and where possible an alternative, to import licensing, Burmese traders should be helped by the Government to make contact with foreign sources and outlets, and to improve their trading methods. The commercial staffs in embassies and consulates in countries with which Burma conducts most of her trade should be strengthened. It may be necessary to employ indigenous experts in these countries. It would be desirable for the Government to bring to Burma a top-grade foreign trade technician who would give direct advice to Burmese traders and also make concrete proposals to the Government on techniques and measures designed to facilitate the Burmanization of trade without protecting inefficiency. A careful study by an expert in the field of foreign trade is needed as a prerequisite to the formulation of an efficient program.

In any case, Burmanization should be administered and with full realization that the costs, in broad terms, must be evaluated against the advantages.

H. SUMMARY OF RECOMMENDATIONS

(1) The Government should prepare, as a partner to the present budget, a "cash consolidated budget" treating all government agencies as one group and showing their combined receipts from and payments to the public, classified between receipts or disbursements within Burma and those abroad, and classified also by type of receipt or disbursement (current or capital). Such a consolidated budget is a basic necessity for intelligent control of fiscal policy.

(2) Budget reporting must be speeded up, so that the records for a fiscal year are available before the budget for the second following year is prepared.

(3) Expenditure authorizations should be separated from expenditure estimates, in order that the latter may not be biased by the need to make the estimate high enough to cover all contingencies. The present system forces exaggerated estimates for expanding programs and makes it necessary to disregard the official budget in order to budget accurately.

(4) Expenditures for current purposes must be controlled. It is recommended that an attempt be made to hold expenditures for all non-defense current purposes during the remainder of this decade to K450 million per year or K50 million above those budgeted for 1952–53. Since new programs once under way create demand for increases in funds which are difficult to resist, advanced budgeting to determine the future expenditures implicit in small beginnings before approving them is necessary.

(5) In restricting current expenditures, expenditures for research, technical training and extension work must not be made the objects of restriction, for these services are key phases of the development program.

(6) Tax rates should not now be increased, but study should be made of a tax increase program if tax increases should become necessary later.

(7) Various changes should be made in present tax laws to remove inequities.

(8) To insure that increasing tax liabilities will be fully reflected in increasing governmental revenues as the national income rises, steps recommended in the report of the Income Tax Administration Advisory Committee for improvement in tax administration should be adopted and the services of one or more tax enforcement experts should be sought.

(9) To remove deterrents to the incentive to produce, various changes should be made in corporate and individual income taxes. The so-called business profits tax should be abolished, other taxes being substituted for it if necessary.

(10) A comprehensive study of the tax structure *as a whole* embracing the questions summarized above, should be made.

(11) Union Bank control of credit expansion by commercial banks should be integrated with other phases of fiscal and monetary policy.

(12) The State Agricultural Credit Bank system should be gradually extended, until there is established in each village a village bank which will be at the heart of a multi-purpose village cooperative society. This expansion of the system, however, must proceed only at the rate at which thorough training of village residents and of administrative officials can be accomplished.

(13) Until this development can be brought about other loans to agriculturists through cooperative societies and direct government loans to agriculturists and small-scale industry should continue, under procedures by which mobile units will reach every village in person, and by which repayment in full will be enforced.

(14) The present experiment in establishing state pawnshops should be pursued energetically but carefully.

(15) Burma need not plan to introduce inefficient industries into Burma to save foreign exchange; her foreign exchange prospects are good.

(16) Tariffs rather than import licensing should be used to protect infant industries.

(17) If import licensing is continued to foster Burmanization of import trading, licenses should be issued for as large a quantity of imports as would enter under free trade, but with restriction of the number issued to non-nationals; and positive steps should be taken to aid Burmese traders in establishing efficient contacts with foreign suppliers and efficient trading procedures.

(18) To diminish the pressure of spending within Burma, restrictions on remittances abroad should be relaxed. Cautious experimentation should be made to determine the volume of funds which would seek to leave Burma if restrictions on export of capital were relaxed.

CHAPTER V

ORGANIZATION FOR COORDINATING THE PROGRAM

Having determined to achieve the fullest possible development of the country's productive resources by the end of the current decade, and to promote to the fullest possible extent the welfare of the Burmese people, the Government of the Union of Burma not only must formulate plans, programs and policies but must also develop satisfactory means for coordinating and integrating them. The larger the degree of government participation in economic activity, the greater the need for coordination of all activity by Government. Not only must the individual features of the development program be coordinated with each other, but the program as a whole must be coordinated with all other production and utilization of goods and services.

A. THE FOUR MAJOR STEPS IN COORDINATING ECONOMIC ACTIVITY

This chapter is concerned with the organization and activities of central governmental agencies in coordinating economic activity. It therefore does not discuss the planning of individual projects, their execution, or their operation. The major steps in coordination are long-range, over-all planning, annual programming, implementation of supporting policies, and progress reporting and expediting. These are logically successive steps. They do not always lend themselves to precise lines of demarcation, but they provide a sound basis for the allocation of responsibility within the Government. While progress reporting and expediting are distinct functions, they may be discussed in combination because of their intimate relationship with each other.

(1) The over-all planning function in Burma encompasses the preparation of the over-all development plan designed to maximize production by the most effective use of total resources. The plan must incorporate both goals for aggregate output and balance between the various industries and sectors. Planning also involves fiscal, banking and other economic policies designed to govern the distribution of income, the division of total income between consumption and savings, the flow of savings into investment, both public and private, the level of exports and imports and the use of foreign exchange, and other major aspects of economic activity. In addition, planning involves the establishment of functional policies designed to govern the adequacy of both the programmed operating activities and such supporting activities as investigations and analysis, contracting and purchasing, organization and management and personnel and personnel training. It involves also continuous review and possible modification of the comprehensive development plan in the light of changing conditions, both foreign and domestic.

(2) The programming function consists essentially of the formulation of detailed objectives, policies, and programs of action for the year immediately following. The comprehensive plan and program must be carried out in successive steps. There must be a determination, each year, in the light of prevailing and prospective conditions, of how much of the total plan can be achieved in the coming year, and of how this may best be accomplished. Annual programs, in some sectors, may be broken down into semi-annual or even quarterly programs. Provision must be made in programming for the year ahead for lags or failures in certain elements in the program during the current period.

(3) The implementation of central economic policies involves the development of specific economic measures which must be conceived, approved and carried through if the policies decided on as necessary for the program are to be put into effect. These will include not only the major central economic policies discussed in Chapter IV, but also policy in a number of scarcely less important fields, such as wage policy, price policy, agricultural credit policy, and the like, all of which will have a profound significance for the economic development program.

The implementation of functional policies requires the development of standards and specific functional measures which must be likewise conceived, approved and applied generally throughout the program in order to insure against failures through functional incompetence of men, their methods, or their materials and equipment. Goals must be established for the quality of performance or results to be achieved in different areas of the program and general criteria developed to insure the competence of studies, plans, field investigations, contracting and purchasing procedures, operating and management attitudes, personnel training, and the interflow of information and services.

(4) The progress reporting and expediting functions, which may be discussed in combination because of their intimate relationship with each other, entail continuous analysis of the progress being made toward achieving the development goals, the analysis of factors tending to retard or accelerate economic progress, and the expediting of appropriate activities. Statistics bearing on progress must be carefully assembled and incisively analyzed and evaluated, so that those responsible for the progress of the program may at all times have a clear picture of where remedial action is needed, and what kind of remedial action will do the job. With analytic progress reporting of this nature, expediting can be undertaken with good prospects for success.

The operation function consists of the actual execution of each specific project and undertaking. Organization for this will be dealt with separately in Chapter VI.

B. ORGANIZATION FOR PLANNING

A comprehensive plan for the economic development of Burma for the remaining years of the current decade is presented in this Report. Plans for the level of the total output and consumption goals, the magnitude of the investment needs, the appropriate fiscal, monetary and other economic policies for achieving the objectives, the required activities in each sector of the economy, and specific projects within these sectors constitute together a comprehensive framework for Burma's economic development for the remainder of the decade.

The plan presented here should be reviewed by the Government and approved as submitted or with reservations or amendments. Approval in principle would provide each of the ministries and other government organizations concerned with a framework for their own planning and activities.

Many steps have already been taken to improve the scope and reliability of the statistical and scientific information needed for planning. As the results of these efforts become available, it will be possible to give certain aspects of the plan greater refinement and precision. Also, as economic developments both within and outside Burma diverge from those now foreseen and as conditions change in unanticipated ways in the countries from which Burma purchases materials and supplies and to which Burma sells its products, it will be necessary to make revisions in the objectives and policies of the basic plan. Planning is a living function. A plan cannot be made once for all time. It must adapt itself to changing circumstances. The fact that a comprehensive plan has been prepared does not mean there is no more planning to do. Planning in Burma has had a good start. It must be continued.

Though planning must be participated in by all agencies of Government and at both the central and local levels, it must be coordinated as the major function of a single agency. The Ministry of National Planning should therefore continue to bear full responsibility for economic planning. It should review and continually refine and perhaps revise the basic development plan. Some change in the balance between productive sectors may be required, or between the private and public sectors. Experience may indicate that total goals and objectives need some modification. Dedication to the achievement of the objectives set forth in the present development plan should not restrain the Ministry of National Planning from making warranted adjustments in the plan itself; on the contrary, the adoption and implementation of timely and well-considered changes may be regarded as indispensable indices of healthy attention to the plan.

In the development of the present plan, the help of various ministries and boards was sought to the maximum feasible extent. However, in the revisions and modifications which should and will have to be made from time to time in the basic development plan, much fuller participation by other ministries, boards, and agencies of Government should be sought and secured. Each ministry and each agency of Government must play a positive part in the over-all development plan if the plan is to have the best quality and realism. Further, and equally important, successful implementation can be achieved only to the extent that each agency shares a sense of responsibility for the evolution of the plan and accepts responsibility for its share of the execution of the plan.

Participation in the planning process should not stop at the central or national government level. To ensure that the programs adopted respond to the conscious needs and desires of people in the various localities, there must be a means through which people throughout the country can contribute. Such an organizational instrument has been created in the divisional, district, and township Pyidawtha committees which have been assigned responsibility and provided opportunity to recommend projects and programs annually for consideration and possible incorporation by the Government into the national plan. These committees can make a contribution of great significance to the execution of plans and programs as well as to the planning process.

For some time the indigenous staff of the Ministry of National Planning will need economists and engineers from abroad. This need should be reviewed from time to time to minimize reliance on foreign experts and maximize the responsibility of Burmese personnel. Some progress has been made in training Burmese technicians in the field of planning. To the fullest possible extent, this training policy should be accelerated by more education abroad and by added experience under competent guidance at home.

C. ORGANIZATION FOR PROGRAMMING

In programming policies and projects for each year the need for a top-level coordinating government agency is especially great. This need applies with equal force to over-all fiscal and financial policies and to specific projects and functions.

As Chapter IV has indicated, at this stage in Burma's development expansionist and stimulatory fiscal, banking and foreign exchange policies are essential. At some later date, the expansionist effect should be reduced or possibly even reversed. The proper timing of such adjustments and the exact measures appropriate to carry them out cannot now be projected several years in the future. They must be geared to the realities of each current year and prospective conditions during the ensuing year. The timing is extremely important, because it must be based on analysis of the time required for new policies to have the desired effects.

Just as the broad economic policies must be integrated to complement each other in accelerating development, so must activities in the various productive sectors and on individual development projects be coordinated effectively. Available raw materials, power, transportation, manufacturing equipment, management and technical personnel need to be integrated in a practical manner. It would make little sense, for example, to construct a factory without making power available or providing effective management by the time the factory is completed. Perfection in relationships and timing is too much to expect, yet coordination cannot be left to chance. Determination of orders of priority and timing must be the responsibility of a single organization.

The Ministry of National Planning should be responsible for programming. Thus the planning and programming functions will be integrated. The Ministry should set forth the goal for the year's production and should prepare both a schedule of the year's progress on development projects in each sector of the economy and a plan for any needed changes in the fiscal and other economic policies. The annual economic program will then be in essence a budget for the economy of Burma.

The first step in evolving the nation's economic budget for the year should be preparation by the Ministry of National Planning of tentative goals for governmental development expenditures and their composition, for government current expenditures, and for private activity. The Ministry should then submit to each operating agency a tentative target for its developmental expenditure, consistent with the over-all economic budget, and should submit to the Ministry of Finance and Revenue the tentative target for current expenditures together with proposals concerning fiscal and banking policies. Each agency should in response submit its proposed capital expenditure budget, and the Ministry of Finance and Revenue should notify the Ministry of National Planning of the proposed current expenditure and revenue budget. While the agencies will be guided to some extent by the proposed targets they will be free to deviate from them. On the basis of these materials, in close cooperation with the operating agencies and the Ministry of Finance and Revenue, the Ministry of National Planning should prepare its program for the year, and should also discuss with the Union Bank of Burma banking and related policies involved in the program. To the degree that the Ministry of National Planning has sought and received cooperation there should normally be little difficulty in securing acceptance of the program by each ministry and board.

The economic budget should be submitted to the Economic and Social Board for review and approval. If the Ministry of National Planning has found it necessary to submit a program with which an individual ministry or board disagrees importantly, the Economic and Social Board should work with the Ministry of National Planning and the agency concerned to reconcile the difference and must arrive at a final judgement. Similarly, should the Ministry of Finance and Revenue believe that Government's budget should differ materially from that included in the economic budget, the Economic and Social Board must effect the necessary reconciliation in consultation with the two ministries.

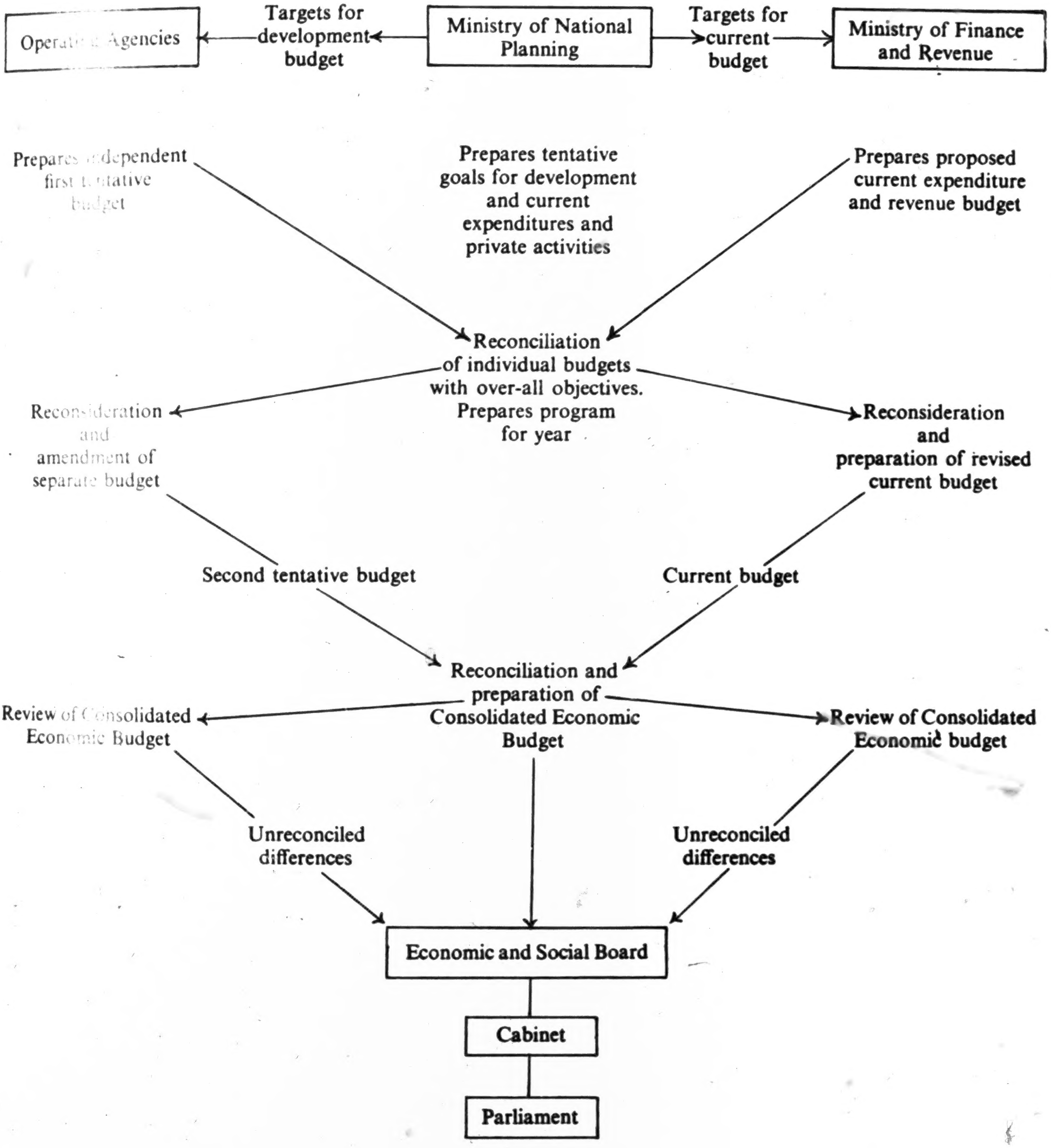
The annual economic budget should then be submitted to the cabinet for approval. Once approved, it serves two chief purposes. First it provides a framework for the Ministry of Finance and Revenue in the preparation of the annual government budget. Secondly, when the program has been approved by Parliament it provides to the individual ministries and boards a framework for their detailed programs for the ensuing year. The chart, Plate 1, illustrates budget and program formulating procedures.

D. STAFF FOR PLANNING AND PROGRAMMING

The preliminary Report made a number of suggestions with respect to the internal structure and staffing of the Ministry of National Planning. No major modification of those suggestions is required here, but two passages may be quoted for convenient

PLATE NO. 1

BUDGET AND PROGRAM FORMULATION


Operating Agencies
Targets for development budget
Ministry of National Planning
Targets for current budget
Ministry of Finance and Revenue
Prepares independent first tentative budget
Prepares tentative goals for development and current expenditures and private activities
Prepares proposed current expenditure and revenue budget
Reconciliation of individual budgets with over-all objectives. Prepares program for year
Reconsideration and amendment of separate budget
Reconsideration and preparation of revised current budget
Second tentative budget
Current budget
Reconciliation and preparation of Consolidated Economic Budget
Review of Consolidated Economic Budget
Review of Consolidated Economic budget
Unreconciled differences
Unreconciled differences
Economic and Social Board
Cabinet
Parliament

Note.—At each stage there is direct consultation between the Ministry of Finance and Revenue and operating agencies on the current budget.

reference. It was suggested that in addition to an administrative staff and a Central Statistical Office, the Ministry should have an Economic Research and Planning Division and a Project and Resource Use Division.

"The Economic Research and Planning Division should be responsible for the preparation of the over-all plan for the country's development on a continuing basis and for recommendations of basic policies. The creation of a staff of economic specialists is an absolute necessity, without which the Ministry of National Planning will not be able to discharge its function adequately. Such a staff should include as a minimum specialists in the following fields: national income analysis; fiscal policy; taxation; money, credit, and banking; foreign trade and exchange; labor and labor relations; marketing and distribution; and cooperatives.

"The Project and Resource Use Division should be responsible for guiding and coordinating the work of the several agencies in the preparation of projects, for evaluating specific projects in relation to each other, and for translating specific project plans into requirements for materials, facilities and manpower. This Division would require a small staff of experts, including specialists in the fields of agriculture, forestry, mining, industry, transportation, power, construction and manpower." To this list of fields should be added, as a minimum, cottage industry, social services and research and development.

The range of experts needed in the Ministry of Finance and Revenue to review and evaluate expenditure programs for current purposes is far smaller, but the present budgeting staff of the Ministry must be greatly strengthened. At the present time, even the detailed budget decisions concerning individual agencies are made by top officials with almost no professional staff whatever. Chapter IV has noted not only the necessity for evaluating many new programs against each other, against existing current programs and against capital programs, but also the need to project several years in the future the expenditure requirements of projects which are expanding or otherwise changing. Without recruitment of added capable professional staff this procedure will not be possible. The judgement of senior officials, based on years of acquaintanceship with the government administration, must be supplemented by thorough analysis prepared for their information by an expanded professional staff.

The general comments made in Chapter VI relating to problems of organization and administration are pertinent here as well.

E. ORGANIZATION AND PROCEDURE FOR IMPLEMENTATION OF ECONOMIC AND FUNCTIONAL POLICIES

Economic policies should be proposed for the long run in the comprehensive plan and for each year in the annual economic budget. These policies should be suggested in broad outline, rather than in detail. Thus if the Ministry of National Planning concludes that for a given year anti-inflationary credit and fiscal policies will be needed, the general measures and steps required of the central bank and of the various ministries of the Government concerned with fiscal operations should be indicated as policies for the period in question. However, there are many intermediate steps to be taken between broad policy proposals, the consideration and elaboration of these policies in detail, and their implementation. If an increase in tax revenues is recommended, consideration must be given to such matters as which groups should bear the burden and what rate increases will bring the additional revenues desired. If, to tighten credit, an increase in the reserve requirements for scheduled banks is proposed, there must be considered what increase will achieve the desired objective and what action, if any, should be taken concurrently with respect to interest rates on various types of government loans or Union Bank loans. Similarly, broad functional policies affecting both the operations and the support of the operating agencies must be explored and reconciled with the various ministries concerned. Such questions cannot fully be explored by the Ministry of National Planning.

Clearly, responsibility for the considered review of economic and functional policy proposals must be fixed in the agency which will be responsible for supervising their implementation; namely, the Economic and Social Board. The Board having reviewed and obtained cabinet approval of policy proposals should direct the ministries and agencies concerned to submit concrete and detailed recommendations in connection with policies to be adopted and implemented. For instance, if the cabinet approves the proposal of the Ministry of National Planning for a tax increase, the Economic and Social Board should request the Ministry of Finance to formulate a specific program in harmony with the board policy proposals of the Ministry of National Planning. The resulting tax proposals should be subject to the approval of the Economic and Social Board, which must carry the primary responsibility for assurance that these policies are coordinated with other basic policies. In the area of credit expansion or contraction, the Board should secure from the Union Bank of Burma a specific program which it will review and approve. The same procedure will apply in other areas.

Where given policies directly affect the functions of various ministries, the Board should secure the fullest cooperation of every such agency in the preparation of properly coordinated and integrated policies. In the field of transportation, for example, the Board should exercise approval authority of rate structures proposed by the Transport Commission, since these directly affect many ministries and agencies. In short, the Economic and Social Board should act much as a subcommittee of the cabinet.

F. ORGANIZATION FOR PROGRESS REPORTING AND EXPEDITING

The body responsible for program review must be given responsibility for keeping track of over-all progress and of progress in various sectors, and must be assigned responsibility for expediting the program. The functions are intimately related. A highly competent staff must prepare regular reports on the progress of the development program for the expediting body. Some of these should be for publication and some should be confidential, for use only within the Government. These reports should include not just statistics, but primarily analysis of program progress, and criticism of lack of progress, along with proposals for accelerating it. They must not deal merely with individual projects but must deal with the inter-relationships between projects and between program areas, and must show the implications for the program as a whole, of lack of progress or of accelerated progress in various projects or areas. In addition to regular reports, the staff should prepare from time to time as required special studies and reports on important policies, problems and projects.

Armed with these analyses, the expediting body can pin-point trouble spots and take the steps necessary to remedy the situation. It should be stressed that the expediting organization cannot in and of itself execute the program. Operations must be handled by operating organizations and agencies. The expediting body can only review progress, analyze reasons for failures to fulfill objectives, make suggestions for improvement and extend assistance where necessary. It cannot do the operations job itself.

Responsibility for progress analysis and for expediting must rest in the body responsible for program review and policy implementation, for each pair of functions depends upon the other pair. Progress analysis and expediting can be done only in relation to the program goals, and conversely annual program proposals or policy changes can be formed realistically only in the light of progress analysis. The body responsible for expediting must be a high-level operating, not the planning, body. Responsibility for progress reporting and for expediting should therefore be vested in the Economic and Social Board.

Progress reporting must however be available to the Ministry of National Planning as well as to the Economic and Social Board, so that the Ministry can take progress analysis fully into account in its annual programming. The progress reporting staff must in effect be a joint staff of the Economic and Social Board and the Ministry.

It is appropriate that the Economic and Social Board has as its chairman the Prime Minister, thus giving it high level authority in its expediting work. But not all the pressure for positive results can be expected to be exerted by the Prime Minister. Obviously he should be called upon to lend his prestige and authority to the expediting of the most important matters, but he must not be called upon every time there is trouble. The "Big Gun" cannot be used all the time. Expediting will not succeed unless most of it is accomplished by the board members and the staff.

Effective expediting, given skillful progress reporting so that the state of affairs is clearly understood, is partly a matter of effective devices and techniques and partly a matter of personal relationships. The mere issuance of critical progress reports or even of directives to operating agencies will not be adequate. The Board and staff should give special consideration to the developing of devices for facilitating and motivating action. They must avoid becoming so critically negative in their relations with operators as to damage their effectiveness. The members of the Board should devote themselves assiduously to the task of knowing what is going on, and of working as closely and harmoniously as possible with the operating arms of the Government. The staff should attempt to develop harmonious relationships with working staffs in the operating agencies, in order to perform as much expediting themselves as possible. There must also be the closest possible relationship between the staff, the Executive Secretary, and board members, so that the staff members will know that they are accurately and fully reflecting board policies and so that the board members will possess more than a formal knowledge of developing problems and can expedite where the staff cannot succeed.

The Board and its staff should not try to expedite where detail is concerned. That is the function of the head of each operating agency. The Board should concern itself with top-level implementation only.

There is no easy road to implementation. Expediters are seldom popular. Effective expediting requires understanding of construction, production and administration, excellent judgement and unlimited tact. The expediter must help the operating head analyze his problem. He must listen more than he talks, and on occasion must be overwhelmingly persuasive. This task is a difficult and demanding one but an essential one for Burma.

G. ECONOMIC AND SOCIAL BOARD STAFF

The size and composition of the staff of the Economic and Social Board must be determined by the functions of the Board. In summary, the major functions of the Economic and Social Board will be: the review and determination of the plans and programs proposed by the Ministry of National Planning; the review and determination of policy proposals with special attention to their details and timing; the review of program progress; and top-level expediting. Staff performance will be divided between these four functions.

The staff requirements will therefore comprise both engineers and economists capable of advising the Board as to the desirability, feasibility and optimum implementation of the plans, programs and policies presented to it, and of assisting it in analyzing the progress made and in expediting where necessary to keep progress on schedule.

Narrowly viewed, the staff work of the Economic and Social Board will be performed by its own staff personnel. Realistically, it would be desirable for the small nucleus of staff of the Board to be supplemented as required by the professional staff of the Ministry of National Planning. The broadest view would regard the staff of the Board as embracing the staff specialists of every government ministry, agency and department as required. This indeed is the proper view. All the specialized manpower resources of Government should be brought to bear on any problem with which the Board has to deal.

H. SUMMARY

(1) The Ministry of National Planning should continue to bear full responsibility for long-range over-all economic planning. The development plan should be subjected to continuing review and refined and modified to fit changing circumstances. In doing this the Ministry of National Planning should give due regard to the suggestions of local Pyidawtha committees and obtain full participation by other ministries, boards and agencies.

(2) The annual economic program will be an economic budget for the nation. The Ministry of National Planning should prepare it in close cooperation with each operating agency and with the Ministry of Finance and Revenue and the Union Bank of Burma. The economic budget should set the goal for each year's total production; should plan the allocation of production between consumption and capital formation; should recommend fiscal and other economic measures for achieving the allocation and for otherwise regulating economic conditions, and should present an allocation of government development expenditures among projects.

(3) The Economic and Social Board should review the economic budget and all aspects of the development program, reconcile any important differences between the Ministry of National Planning and other agencies which the Ministry of National Planning has not been able to resolve, and should submit the final budget and development program to the Cabinet for approval. The approved economic budget and program will provide the framework for the preparation of the annual government budget and provide individual agencies with the framework for their detailed programs for the year.

(4) The Economic and Social Board should be responsible for reviewing and implementing broad economic and functional policies proposed in the comprehensive plan and in each year's economic budget. The board should see that specific proposals and programs are consistent with the broad policy proposals of the Ministry of National Planning.

(5) The Economic and Social Board should be responsible for keeping track of the progress and competence of the development program and for expediting the program. The progress reports should analyze the status of each program and its contribution to the over-all program. They will enable the Economic and Social Board to pin-point trouble areas and effect remedial measures. They will also be needed by the Ministry of National Planning in its annual programming.

(6) The economic and Social Board should concern itself with top-level expediting only. Details should be the responsibility of the head of each operating agency.

(7) The staff of the Economic and Social Board should comprise both engineers and economists capable of advising the Board on all phases of the planning, programming and implementation of the proposals presented to it. The staff should assist the Board in analyzing the progress made and in expediting where necessary to keep the program on schedule. The staff should be supplemented as required by the professional staff of the Ministry of National Planning and specialists of every government agency. All the specialized manpower of Government should be brought to bear on any problem which comes before the Board.

MINISTRY OF NATIONAL PLANNING AND RELIGIOUS AFFAIRS

Social Planning Commission
Economic Planning Commission
Burma Economic Aid Committee
Central Statistical and Economics Office
Census Office
E.C.A. Branch
U.N. and Colombo Plan Branch
Planning, Social and Economic Commission Branch
Census, Statistics and Economics Branch
Pyidawtha Branch
General Administrative Branch
Miscellaneous

Union Buddha Sasana Council
Directorate of Religious Affairs
The Pali University Council Office
The Pali Education Office
Religious Affairs I Branch
Religious Affairs II Branch

MINISTRY OF INFORMATION

Department of Information
Department of Broadcasting
Department of Stage and Films
Government Printing and Stationery Department
Audio Visual Aids Board

Indust
Direct
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Boiler
Super
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Paper
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MINISTRY OF PUBLIC WORKS AND REHABILITATION

Rehabilitation Board
Building and Roads Department
Public Works I Branch
Public Works II Branch
Public Works III Branch
Miscellaneous Branch

MINISTRY OF TRANSPORT AND COMMUNICATIONS

Union of Burma Railways Board
Postal Department
Telecommunications Department
Inland Waterways Transport Board
Board of Management for the Port of Rangoon
Civil Aviation Department
Union of Burma Airways Board
Mercantile and Marine Department
Union of Burma Shipping Board
Burma Meteorological Department
Road Transport Department

MINISTRY OF AGRICUL

State Timber Board
Agriculture and Water Resource
Agriculture Department
Forest Department
Veterinary Department
Fisheries Bureau
Sugar Control Board
Irrigation Department
Agriculture Credit Department
Salt Department
State Land Committee

MINISTRY OF UNION CULTURE

Cultural Department
State Library, Museum, Art Gallery
State School of Fine Arts & Music & Drama (Rangoon)
State School of Fine Arts & Music & Drama (Mandalay)
Department of Archaeology
State Musical Troupes
Dha Ka Branch
Dha Kha Branch

MINISTRY OF SOCIAL SERVICES

Directorate of Health Services
Directorate of Social Welfare
National Health Council
National Fitness Council
Medical I Branch
Medical II Branch
Medical III Branch
Medical IV Branch
Medical V Branch
Special Branch
General Branch
Local Government General Branch
Local Government Administrative Branch
Local Government Municipal Branch
Local Government Rural Financial Branch

MINISTRY OF RELIEF AND RESETTLEMENT

Rangoon Welfare Committe
Mobile Relief Party
Recovery I Branch
Recovery II Branch
Recovery III Branch
Relief I Branch
Relief II Branch
Miscellaneous Branch

NOTE.—In the case of three pairs of ministries (designated by the figures 1, 2, and 3 respectively), one minister present

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MINISTRY OF INFORMATION

Department of Information
Department of Broadcasting
Department of Stage and Films
Government Printing and Stationery Department
Audio Visual Aids Board

MINISTRY OF I

Industrial Development Co
Directorate of Industries
Electricity Supply Board
Boiler Inspectorate
Superintendent Cottage In
Government Spinning & W
Paper Factory & Chemical
Electricity Inspectorate
Weaving Institutes & Lacq
Directorate of State Aid to
Industrial Research Institu

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MINISTRY OF AGRICULTURE AND FORES

State Timber Board
Agriculture and Water Resources Development Corp
Agriculture Department
Forest Department
Veterinary Department
Fisheries Bureau
Sugar Control Board
Irrigation Department
Agriculture Credit Department
Salt Department
State Land Committee

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nment Municipal Branch
nment Rural Financial Branch

MINISTRY OF RELIEF AND RESETTLEMENT

Rangoon Welfare Committee
Mobile Relief Party
Recovery I Branch
Recovery II Branch
Recovery III Branch
Relief I Branch
Relief II Branch
Miscellaneous Branch

FOREIGN

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Foreign Servic
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Foreign Intelli
Political Branc
Consular Bran
Protocol Branc
General Branc
Immigration B
Passport Branc
Administratior

by the figures 1, 2, and 3 respectively), one minister presently holds two portfoli

CHAPTER VI, PLATE I

PRESENT MINISTERIAL ORGANIZATION GOVERNMENT OF THE UNION OF BURMA

(As of 15th July 1953)

PRIME MINISTER

Economic & Social Board
Bureau of Special Investigation

INDUSTRY

Corporation

Industries
Weaving Factory
l Industries Board

quer School
to Industries
ute

MINISTRY OF MINES 1

- Mineral Resources Development Corporation
- Mining Adviser & Chief Inspector of Explosives
- Burma Geological Department
- State Mineral Produce Marketing Board

MINISTRY OF COMMERCE 2

- State Agricultural Marketing Board
- Import Licensing Board
- Army Surplus Disposal Board
- Accounts and Administrative Branch
- Information Branch
- Procurement Branch
- Licensing Policy Branch
- Licensing Branches
- Legislation Branches
- Statistics Branch
- Treaties and Development Branch

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MINISTRY OF CO-OPERATION AND COMMODITY DISTRIBUTION 2

- Civil Supplies Management Board
- Cooperative Societies Department
- Cooperative I Branch
- Cooperative II Branch
- Project Branch
- Civil Supplies Branch
- Miscellaneous & Accounts Branch

MINISTRY OF LAND NATIONALIZATION

- Land Nationalization Department
- Settlement and Land Record Department
- Survey Department
- Registration Department
- State Colonies Department

**MINISTRY OF
OF LOCAL**

Rule Drafting C
Legislative Bran
General Branch
Implementation

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MINISTRY OF JUDICIAL AFFAIRS

- Judicial Branch I
- Judicial Branch II
- General Branch
- Citizenship Branch
- Miscellaneous Branch
- Legislative Branch I
- Legislative Branch II

CHIN AFFAIRS MINISTRY

- General Administration
- Education Department
- Cooperative Department
- Public Relations
- Medical & Public Health
- Public Works Department
- Veterinary Department
- Judicial Department
- Postal Department
- Telecoms. Departments

KACHIN STATE MINISTRY

- Kachin State Government
- State Minister for Finance & Revenue
- State Minister for Education, Public Health & Medicine
- State Minister for Agriculture & Forests

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CHAPTER VI, PLATE I

PRESENT MINISTERIAL ORGANIZATION GOVERNMENT OF THE UNION OF BURMA

(As of 15th July 1953)

PRIME MINISTER

Economic & Social Board
Bureau of Special Investigation

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MINISTRY OF MINES 1

Mineral Resources Development Corporation
Mining Adviser & Chief Inspector of Explosives
Burma Geological Department
State Mineral Produce Marketing Board

MINISTRY OF COMMERCE 2

State Agricultural Marketing Board
Import Licensing Board
Army Surplus Disposal Board
Accounts and Administrative Branch
Information Branch
Procurement Branch
Licensing Policy Branch
Licensing Branches
Legislation Branches
Statistics Branch
Treaties and Development Branch

MINIST

Directorate
Inspectorat
Union Insur
Rangoon De
National Ho
Standing Joi
Labour Legi
Dock Labou
Court of Inc
Tile Factory
Urban Rent
Labour I Bra
Labour II Br
Labour III B
Labour IV B
Labour V Br

MINISTRY OF CO-OPERATION AND COMMODITY DISTRIBUTION 2

Civil Supplies Management Board
Cooperative Societies Department
Cooperative I Branch
Cooperative II Branch
Project Branch
Civil Supplies Branch
Miscellaneous & Accounts Branch

MINISTRY OF LAND NATIONALIZATION

Land Nationalization Department
Settlement and Land Record Department
Survey Department
Registration Department
State Colonies Department

MINISTRY OF DEMOC OF LOCAL ADMIN

Rule Drafting Committ
Legislative Branch
General Branch
Implementation Branch

MINISTRY OF JUDICIAL AFFAIRS

Judicial Branch I
Judicial Branch II
General Branch
Citizenship Branch
Miscellaneous Branch
Legislative Branch I
Legislative Branch II

CHIN AFFAIRS MINISTRY

General Administration
Education Department
Cooperative Department
Public Relations
Medical & Public Health
Public Works Department
Veterinary Department
Judicial Department
Postal Department
Telecoms. Departments

KACHIN STATE MINISTRY

Kachin State Government
State Minister for Finance & Revenue
State Minister for Education, Public Health & Medicine
State Minister for Agriculture & Forests

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State Minis
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State Minis

STRY OF HOUSING AND LABOUR

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te of Factories and General Labour Laws
rance Board
Development Trust
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t Control
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MINISTRY OF FINANCE & REVENUE

Standing Finance Committee
Fiscal Committee
Surtee Bara Bazaar Administration Board
Land and Survey Branch
Excise and Taxes Branch
Customs Branch
Budget Branch
Public Accounts Branch
Ways and Means Branch
Currency and Banking Branch
Projects Branch
Claims Branch
Pensions Branch
Civil Branches
Accounts Branch
Statistics and Miscellaneous Branch
Savings Scheme Branch

MINISTRY OF HOME AFFAIRS

Public Service Commission
Secret Branch
Police Branch I
Police Branch II
Miscellaneous Branch
General Branch
Accounts Branch
Appointment Branch I
Appointment Branch II
Security Branch
  (a) Law and Order
  (b) Fire Services
Civil List Branch

CRATIZATION NISTRATION

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WAR OFFICE

1

Permanent Secretary's Department
Chief of General Staff Department
Adjutant General's Department
Quartermaster-General's Department
Chief of Naval Staff Department
Chief of Air Staff Department
Military Secretary's Department
Judge Advocate-General's Department
Office of the Controller of Military Accounts Burma

MINISTRY OF EDUCATION

Directorate of Public Instruction
Directorate of Teachers Training
Directorate of Technical Education
National Commission Secretariat
Directorate of Text Book Production
Mass Education Council
Union Youth Council
University College, Rangoon
University College, Mandalay
Intermediate College, Moulmein
University for Adult Education (Rangoon and Akyab)
Education I, II, III, IV & U.N.E.S.C.O. (Branches)

SHAN STATE MINISTRY

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e Government
ister for Information
ister for Education
ster for Health
ster for Works
ster for Agriculture, Forests, Land Utilization,
inary, & Cooperative
ster for Finance & Revenue

KAREN AFFAIRS MINISTRY

Karen State Government
Minister for Finance & Revenue
Minister for Education
Minister for Transport & Communication
Minister for Religious Affairs & Information
Minister for Relief and Resettlement
Minister for Agriculture, Forests & Mines

KAYAH STATE MINISTRY

Kayah State Government
Publicity Officer
Agricultural Officer
Resident Kayah State, Loikaw
Medical Officer, Loikaw
Principal Works Officer, Taunggyi
Principal Veterinary Officer, Taunggyi
Principal Education Officer, Taunggyi

[illegible]

Religious Affairs I Branch
Religious Affairs II Branch

State [illegible] Board
Agricultural [illegible]
Agriculture Department
Forest Departments
Veterinary Department
Fisheries Bureau
[illegible] Control Board
Irrigation Department
Agricultural Credit [illegible]
Soil Department
State Land Committee

[illegible] OF SOCIAL SERVICES

[illegible] of Social Welfare

Refugee Welfare [illegible]
[illegible] I Branch
[illegible] II Branch
[illegible] III Branch
Relief I Branch
Relief II Branch

CHAPTER VI

ADMINISTERING THE DEVELOPMENT PROGRAM

A. THE MINISTRIES

Consideration of how governmental organization and administration in the ministries can be improved to carry out more effectively the economic development program should take into account the assignment of responsibilities and functions among the various ministries and the internal organizational structure within the ministries, as well as the problems of personnel and operating procedures which are common to other agencies and are discussed later in the chapter.

1. ASSIGNMENT OF MINISTERIAL RESPONSIBILITIES

The Cabinet is composed of 23 ministers who head 26 ministries; three of the ministers hold double portfolios. The question naturally arises as to whether the assignment of government functions and responsibilities among the ministries might not be improved by judicious consolidation. In every government there is apt to be a tendency toward proliferation of cabinet-level agencies. This alone would probably warrant a periodic re-examination of the distribution of responsibilities for the various governmental functions, in order to consolidate closely related functions and to achieve greater operating efficiency. Another reason for such a re-examination is that as government policies change to take on new emphasis in response to changing conditions, a modified allocation of responsibilities may be more appropriate to the new conditions and policies. There are other compelling reasons why the various governmental responsibilities should be divided to the extent possible among a relatively smaller rather than a relatively larger number of ministries. Where superior executive and administrative abilities are in great demand, reduction in the number of ministers and secretaries will result in the availability of more able people for key posts elsewhere in the development program. Finally, where two or more closely related ministries are not consolidated, many questions will arise which will require coordination of their activities, or reconciliation of their differing views at a higher level. This will impose an unnecessarily heavy load on the Cabinet and on the Prime Minister. The responsibilities of the Prime Minister and of the Cabinet are already so burdensome that it would seem highly desirable to minimize to the greatest possible extent that part of the burden which arises out of the necessity for such coordination and reconciliation.

The above observations arise not merely from study of the situation in Burma. They are theoretical as well. Such consideration as it has been possible to give to the ministerial structure in Burma has not been detailed. Nevertheless, even a superficial examination of the structure of the present ministries, as shown in Plate I, suggests that in a number of instances functions presently distributed among two or more ministries might be consolidated in one ministry with useful results. Thus, for illustrative purposes, it is suggested that consideration be given to the consolidation of the Ministry of Culture with the Ministry of Education; of the Relief and Resettlement Ministry with that for Social Services; of the Land Nationalization Ministry with the Ministry of Agriculture and Forests. A considerable number of more far-reaching consolidations might be proposed. It may well be that there are good and compelling reasons in some of these instances for the separate existence of the ministries concerned. What is suggested is that a thorough study of the allocation of governmental responsibilities among the several ministries conducted by competent experts might lead to greater administrative efficiency and more rapid attainment of the goals of the development program.

2. INTERNAL MINISTERIAL STRUCTURE

Such examination of the internal structure of several ministries as it has been possible to make suggests that, in a number of instances, reorganization of existing organizational structures within the ministries would assist in the improvement of their operations. The internal organization of the ministries in large part is an inheritance from the colonial administration, when the Government played a lesser role in the direction of economic life in Burma than is now the case. What seems to be lacking in these instances is a structure in which separate organizational units and sub-units are established with a clear delegation of authority for certain functions for which the ministry as a whole has responsibility.

A desirable organizational structure may be illustrated as follows: if a given ministry has responsibility for six major functions, it should be so organized internally that six separate organizational units within the ministry are each assigned responsibility for one of those functions. The officers in charge of each of the six major organizational units should report directly to the secretary and the minister. If a larger number of major functions exist, they should normally be combined so that six or a smaller number of persons report directly to the secretary and minister. Normally, each of the major units should be further sub-divided with the same clear assignment of responsibility. In the language of public or business administration, such an organizational structure is called an administrative pyramid or hierarchy. The pyramid does not normally constitute the entire organization of the ministry; there may for example be at one side a planning unit concerned with all the work of the ministry, but it must merely be advisory to the top officials and must not blur the lines of responsibility by sharing with them responsibility for operation. There must also be clear arrangements for coordination between units, but these arrangements must not diffuse responsibility or create conflicting lines of authority.

The internal structure of many ministries in Burma seems not to be organized in this manner. A number of the ministries seem rather to be organized in such a way as to foster undue deliberation, an excessive number of lateral clearances, delays and blurred responsibility and accountability. It has been stated that, in some instances, nobody seems to be clearly in charge of anything. The internal structure within each ministry should be one which encourages the orderly delegation of responsibility, prompt action and sharply focused accountability for results in specific areas of responsibility.

Another defect of the top-level structure of the executive branch is the lack of "deputy ministries." Ministers are frequently on tour, both in the course of their executive duties and for legitimate political and other purposes. When they are away, work on important matters often comes to a standstill. The secretary is hesitant to make decisions, except on relatively minor matters, and business is delayed. Efficiency would be increased if some official acquainted with the minister's views and the principles which guide his decisions were placed in position to make final decisions in the absence of the minister. Perhaps the elevation of parliamentary secretaries to the role of "deputy ministers" is a feasible solution.

B. THE DEVELOPMENT CORPORATIONS

The Agricultural and Water Resources Development Corporation, the Industrial Development Corporation and the Mineral Resources Development Corporation have major roles to play in the economic development program. These organizations have been established by acts of parliament vesting imposing responsibilities in them. The duty of the Industrial Development Corporation is to promote the establishment and development of industrial enterprises. The responsibility of the Mineral Resources Development Corporation is the exploitation, development and utilization of the nation's mineral resources. The Agricultural and Water Resources Development Corporation has the task, under its act, of sponsoring construction of irrigation canals, dams and reservoirs, making loans to farmers, and taking other measures to expand agricultural production. The Industrial and Mineral Resources Corporations are specifically authorized to carry out all activities necessary to their functions; and the powers granted to the Agricultural and Water Resources Development Corporation are correspondingly broad. The three have tremendously significant roles to play in the development program. It is therefore important to consider some of the major organizational and administrative problems which arise in connection with their activities.

1. AUTONOMY

First and foremost among these is the question of autonomy, namely, the proper balance between independence and democratic accountability. Experience indicates that the best answer here is for the development corporations to be organizationally outside of the ministries, and to enjoy complete freedom in respect to day-to-day decisions. In broad policy matters each may report to an appropriate minister, or alternatively the head of the corporation may himself have cabinet status. If the former arrangement is followed, as seems to be preferable, the minister should guide only the broad lines of over-all policy. If a development corporation acts merely as a division of a ministry, one of its main aims is frustrated. On the other hand, there must be effective provisions for integration of the corporation's operations with over-all government policy.

2. DIRECTION

Another extremely important and closely related aspect of the problem of organizing and administering development corporations has to do with the composition of board membership, and with the nature of the direction of the corporations. Experience in other countries has shown that where membership on the board of directors of a development corporation is heavily weighted with government officials, and especially with representation of ministerial rank, there is a tendency for such a board to be dominated by the minister or ministers and to lose its autonomy and vigor of action. Experience in other countries has also led students of the question to the opinion that the chairman of the board of such a corporation should serve on a full-time basis, free of any other public or private responsibilities. Compelling reasons may of course exist for deviating from this general rule. Where the chairman of a development corporation cannot devote himself exclusively to its affairs it becomes the more imperative that the director-general or managing director of the development corporation be a person of the highest capability and willingness to accept the fullest possible range of authority and responsibility, subject only to the general policy guidance and review of his board and board chairman, and that the board in fact delegate such authority and responsibility to the director-general.

3. AVOIDANCE OF DIRECT OPERATIONS

The function of a development corporation with respect to new development projects should be to see to it that such projects are undertaken by bodies appropriate to the purpose. If, for example, it is desired to initiate a new pulp and paper plant, the Industrial Development Corporation should see to it that the job is done; it should not undertake the task itself. The Industrial Development Corporation may set up an autonomous, businesslike publicly owned corporation to do the job; it may make arrangements for a joint venture, in which government and private capital would jointly undertake the task; or it may insure initiation and proper execution of the project in any other way which seems desirable and feasible. The Industrial Development Corporation itself, however, should not become engaged in direct operations. Its role should be confined to initiation, financing and the subsequent exercise of such controls as would be appropriate to any large owner of an enterprise, to insure that it was well managed and efficiently operated. If the development corporations go beyond the exercise of such functions, and extend themselves into the sphere of actual operations, they will become hopelessly bogged down in detail, and they will be unable to carry on their development activities on the scale and with the objectivity required for satisfactory performance.

4. FOSTERING PRIVATE ENTERPRISE

While the responsibilities of the development corporations will undoubtedly be primarily the initiation and guidance of new development projects, an exceedingly important aspect of their work, and one which should not be slighted, should be the encouragement and fostering of modernization and expansion by existing private enterprises. This can be done more effectively, and without diverting time and energies from the basic task of new development, if separate divisions with separate personnel are established in the development corporation to handle these essentially different, although complementary, jobs.

5. BOLD CONCEPTS

It is important that the managements of the development corporations think in large terms, and that they display imagination, enthusiasm and energy in their approach to their tasks. Management must not be timid or hampered by fears of petty criticism from higher authority because of mistakes that are bound to be made in good faith by the most capable of people, if they are doing a dynamic job. One of the chief purposes of development corporations is to provide organizations which can act boldly and responsibly, unhampered by the many restrictions which so often make action by government agencies cautious and time-consuming. It is essential that the boards of directors of the development corporations approach their responsibilities with a determination to do a big imaginative job in a dynamic way, and that they convey this feeling and attitude to the executive officers of the corporations. In fact, the managing director of a development corporation should be made to feel that unless he undertakes a large-scale and ambitious program, and seeks to accomplish it in a relatively short time, he will be subject to censure by his board.

This vigor of action does not mean action uncoordinated with the rest of the Government. The scope of the program of each development corporation must be planned in relation to the over-all plan and the annual program whose formulation is discussed in Chapter V. But each corporation will not be a passive recipient of an assignment within that plan. It must propose action, indicate the work it is prepared to carry out and its desirability, and so partake actively in the formulation of the over-all plan.

6. FUNDING POWERS

It is exceedingly important that the development corporations be empowered to finance new and existing enterprises, whether by loans or equity participation, that they be empowered to raise money by the issuance of bonds, debentures and stocks, and that they be empowered to raise very substantial sums initially for these purposes without the necessity for seeking further specific authority for so doing. Initial authority to employ substantial sums before being required to obtain further financial authority will help develop the necessary vigorous approach to the development program.

7. STAFFING

If the new corporations are to perform the major role assigned to them in the development program, it is essential that they swiftly build up sizable staffs composed of capable people with adequate training and experience. In June, 1953, after the Industrial and Mineral Resources Development Corporations had been in existence for eight months and the Agricultural and Water Resources Development Corporation for a slightly shorter period, the total staff of the Agricultural and Water Resources Development Corporation, including stenographers and messengers, was reported as including less than two dozen persons, and of the other two corporations combined, a smaller number. It is important that the development corporations proceed without delay to recruit necessary staff of the highest possible caliber in order to be in a state of readiness for operations once programs and projects presently under consideration are approved.

8. INTERNAL STRUCTURE

As in the case of the several ministries, it is highly important that the internal structure of the several development corporations be appropriate to the execution of their functions. The specific internal organization of a corporation should differ from that of a ministry, because of the difference in functions, but the same principles of organizations divided according to function, with clear-cut lines of authority and responsibility and clear provision for internal coordination of related functions should govern.

C. OTHER GOVERNMENT CORPORATIONS AND BOARDS

Like other modern governments, the Union Government has found it advisable to create a variety of other corporations and boards. These fall into three groups: state enterprises presently or potentially engaged in the production of commodities, such as the State Cotton Spinning and Weaving Factory Board, the State Timber Board (which also has other functions), the Tile Factory Board; state enterprises engaged in other productive activity, such as transportation or marketing; and boards engaged in regulatory activities.

Comment has already been made concerning the appropriate relationship between the development corporations and subsidiary operating corporations. The latter should be set up in simulation of private business corporations, and be guided by the same principles of good management, good service and reasonable profit as should motivate the privately owned corporation which has a sense of public responsibility. The direction of such a corporation should be in the hands of a board of directors selected, not on the basis of political considerations, but on the basis of the capabilities and experience they can contribute to the policy direction of the enterprise.

Where actual production activities are presently engaged in by existing government boards, these should be converted to public corporations subsidiary to the appropriate development corporation, and thus made part of a uniform organizational plan. New legislation will in some instances be required to accomplish this.

The problem of the quality of management of existing and prospective state enterprises is crucial. Probably no other aspect will be so important a determinant of their success or failure. Management is further discussed in Chapter VII.

The organizational and operating problems of the transport, marketing and other productive boards are similar to those of the boards engaged in commodity production. Those of the regulatory boards differ. Careful studies are needed of both types of bodies, with respect both to their internal organization and procedures and to their direction and administrative relationships to other agencies. In some cases the chapter of this report dealing with a given field makes recommendations concerning the direction, organization and operation of the government board or boards operating in it.

D. PROBLEMS OF PLANNING, REPORTING AND EXPEDITING

Successful administration of any agency requires that the top executive be informed concerning the relationship between the agency's goals and those of related organizations, the degree to which the agency's work is progressing satisfactorily toward those goals, and the need for special attention to problem areas of the agency's work. In any large agency, special arrangements are necessary to accomplish this most effectively.

In agencies carrying out a changing program rather than merely a continuing operation, such arrangements are especially important. This will be true of almost every agency of the Union Government during the period of the development program. Specific arrangement is necessary within each agency for planning, reporting and expediting.

In Chapter V it was emphasized that planning of specific projects and programs must typically originate in the operating agencies rather than in the Ministry of National Planning or any other central body. The formulation of an integrated program must be a process of mutual fertilization, stimulus and adjustment between the planning agency and the operating agency. Each operating agency must "feed" ideas and information to the central planners. Without such aids, central planning soon becomes sterile and unrelated to actual conditions "on the front line" of the work of Government. Conversely, each operating agency must receive from the central agency a clear understanding of the role of its work in the over-all plan. Without it, cooperation in executing programs is not as effective as is possible.

It was also pointed out in Chapter V that expediting by the Economic and Social Board must not enter within the operating agencies; expediting within the agency must be done by the agency itself. There are several good reasons for this. In the first place, the staff of an implementing ministry or development corporation will commonly know much more about one of its projects than will anybody in the central planning or coordinating groups. Secondly, the operating agency will be legitimately resentful if there are unsolicited intrusions in matters which are properly within its jurisdiction. Third, in addition to the resentment generated, interference within the area of responsibility of an implementing agency weakens energy and initiative and is apt to retard the solution of the problems which required the expediting action.

The top official of each government ministry, department or agency will, of course, be responsible for both planning and implementation. The first requirement for effectively carrying out this responsibility is capable people and proper organization and procedures throughout the agency. The principle of the administrative pyramid has been discussed.

The second requirement is effective assistance by one or more officers or groups who are in a "staff" rather than a "line" relationship to him; that is, who are direct advisers to the head but without administrative responsibility or authority over operating units. Each agency should have at least one such planning and implementation officer and unit under him. The officer should be attached administratively to the secretary, in the case of a ministry, or to the chief executive officer of the government agency concerned. He should be strictly a staff adviser, having no executive authority in his own right; any other arrangement would tend to blur responsibility and accountability by interfering with the prerogatives of the line executives whose job is the actual execution of programs and projects.

His planning function should consist not merely of initiating project plans, but also in translating, in terms of the work of his agency, the Government's over-all plans, and in making continued adjustments in the agency's plans in the light of changing conditions. His planning should be solidly based on the factual data gathered and analyzed by the research and statistics section of the agency, which he should direct.

He should develop and maintain a progress reporting system. This should show the status of each major program, of all the projects composing it, and of the component elements of each project, all in relation to pre-established time schedules. Where programs, projects, or parts of projects are falling behind schedule, he should attempt to discover the reasons, and should recommend corrective measures. Where performance is ahead of schedule he may make recommendations for advancing the schedule or for shifting resources to other programs or components of programs which are lagging. Thus the planning and expediting functions merge.

It is extremely important that expediting staff avoid issuing orders or edicts. Informal personal contacts, conferences and brief memoranda will be the principal tools. Any orders which the expediters may consider necessary should be issued by one of the heads of the agency concerned; the expediters must not constitute separate lines of authority reaching down into units.

The expediters should, in the course of dealing with actual cases, recommend administrative improvements which will prevent the recurrence of the problem. This is the most important aspect of an expediter's job; preventing recurrence of failure by administrative improvement multiplies his effectiveness many-fold.

E. OTHER GENERAL PROBLEMS

1. PERSONNEL TRAINING, RECRUITMENT AND MANAGEMENT

The pervasive shortage of trained and experienced administrators and specialized workers, mentioned repeatedly throughout this Report, is as acute in government administrative agencies as elsewhere in the economy. The needs of the development program require early and large increases in the staffs of a number of key ministries. Analysis, as previously recommended, of the internal organizational structure and procedures of the several ministries is bound to involve estimates of the number and kind of personnel necessary to execute efficiently the responsibilities assigned. Analyses should provide quantitative appraisal of the personnel needs of the several ministries and of the Government Executive Department as a whole. Somewhere the necessary trained and experienced people must be found.

a. Training

The problems of training specialized workers for government service are similar to training problems for any other organization. Such problems are discussed in Chapter VII. One special type of training should, however, be instituted: training in public administration itself. To this end the University of Rangoon (and Mandalay College if maintained as a four-year college) should establish a public administration curriculum including courses to teach the role of the Union Government in the economy, the purposes of the development program and the requirements for its success, the principles of government organization and operation, public personnel administration and similar matters. The Ministry of Home Affairs, either independently or in appropriate circumstances in collaboration with the University, should conduct public administration in-service training and research available to suitably qualified personnel of all public agencies. In addition, scholars and officials should be sent abroad for postgraduate public administration studies and practical observation.

In the Government as elsewhere, in-service training can contribute greatly to efficiency. The worker who is plunged into a job without understanding its relationship to the over-all work of the agency or to other jobs is not effective as he might otherwise be. Further, the worker's effectiveness is increased if he is offered a means of preparing for promotion as he works. In-service training of both types should be introduced. A Center for Training Aids is recommended in Chapter VII. Its services should improve the effectiveness of orientation and in-service training throughout the Government.

b. Recruitment

There should be well-defined and well-publicized avenues into the public service. Yet the majority even of educated Burmese seem to have slight knowledge of routes into a public service career. The Ministry of Home Affairs should, therefore, regularly publish and disseminate bilingual cumulative announcements of all vacancies, the qualifications needed and procedures for applying. Through arrangements with the Director of Posts, these announcements should be exhibited in post offices throughout Burma. The Ministry of Home Affairs should also collaborate with the Ministry of Information to issue and widely distribute a readable and attractive bilingual pamphlet describing opportunities in Burma's public service and steps necessary to qualify for positions.

Every effort should be made (*a*) to encourage promising young people to aspire to government service, (*b*) to guide them in taking appropriate training, and (*c*) to make sure that, once they are properly qualified, they can, without hindrance or undue "red tape," receive public service appointments. To this end the Ministry of Home Affairs and the Ministry of Education should cooperatively foster the establishment of guidance programs at high schools, technical institutes, Mandalay College and the University of Rangoon, with the object of interesting promising students in public service careers and of counseling them in respect to proper training for such careers.

In addition, Government should study the need over the next few years for temporary foreign personnel and should develop more systematic means for recruiting such people. An important function of such experts should be to teach the maximum number of Burmese to understudy their work and to perform specialized jobs; this function should be stressed in recruiting such experts.

c. Conditions of Work: Salary Scales

Success in recruiting personnel depends in part on the conditions of work to which people are being recruited. The desirability of in-service training has been mentioned. The general atmosphere of work, discussed in Chapter VII, is as important in Government as elsewhere. There are other questions. Are government pay scales adequate to attract and to keep in Government desirable personnel of the capabilities desired? Are existing personnel practices such as to encourage the most able staff members to exert themselves to the fullest extent of their capabilities in the search for monetary rewards or promotion? Without intensive study of such questions, a few general observations can be made.

The time would seem to be long overdue for adopting pay scales adequate to meet the existing cost of living of government employees. Present salary scales are too low to attract and to retain in government service people of the desired qualifications and abilities, and a general pay increase throughout the government service would seem to be in order. This recommendation is made with due consideration of the desirability mentioned in Chapter III of limiting current government expenditures. A salary increase is an expenditure which it would be wasteful not to make. The caliber of government workers of some types and grades is low because even at the reduced level of private activity the best workers find it possible to obtain positions in private industry paying much higher salaries; many leave government service to accept them.

In considering such a general pay increase, it must be kept in mind that the most significant services are those performed by officials at the upper end of the civil service ladder. These highly responsible officials, plus those in the ranks next below, merit increases just as much as do those at the lower end of the salary scale. Reaction against the top civil service salaries under the British regime, which were based upon British living standards and were believed excessive, plus the financial crisis of 1948–49, have caused a reduction in top-level salaries to much below the prewar level in spite of the several-fold increase in living costs since before the war. Even though the top salaries may have been adequate, the reduction of 75% or more in purchasing power is conducive to inefficient administration and is contrary to the public interest.

Consideration of a general salary increase throughout the government services should be linked with investigation of the extent to which standards of performance may be raised, more efficient workers employed, and currently employed inefficient personnel released. Many government positions are of such a nature that the actual work accomplished per day varies tremendously, depending on the efficiency of workers. An inefficient typist or clerk, even though paid a low monthly wage, is a very expensive employee. In many posts, the work would be done at considerably lower cost to the Government if the salary paid were higher. A study of the possibility of increasing efficiency would be necessary in order to estimate the increase in expenditures which would be required by a general wage income.

One road to increased output per worker should be lengthened hours of work. Presumably, the higher the productivity in an economy, the larger the share of time which can be afforded for leisure and the shorter need be the number of hours devoted to labor. Yet in none of the higher productivity countries of the world is it deemed feasible to afford as short a work week in government employment as is the practice in Burma. This practice like others referred to above is apparently a colonial practice, which an independent nation striving for an increased level of living cannot afford. Effective institution of a longer, work week, at the time of a general pay increase, could offset a considerable share of the cost.

Improved office procedures, discussed below, could also offset the cost of a pay increase.

d. Personnel Management and Administrative Management

A central personnel management staff and a central administrative management staff (often combined) are accepted parts of the government structure of most countries. Their effectiveness depends on the degree to which their work is integrated with the execution of the current work and problems of the operating agencies. The planning-reporting-expediting unit recommended in previous paragraphs for each agency would in effect constitute an administrative and personnel management unit oriented toward the solution of pressing current problems. Similarly, the expediting staff of the Economic and Social Board, discussed in Chapter V, would constitute a central administrative management staff. The improvement of procedures and organization to prevent recurrence of problems and to increase the efficiency of work is one of its central functions. The need for administrative talent and experience in administrative analysis must be recognized in selecting its staff. The staff should not be thought of as merely an *ad hoc* group meeting emergencies.

2. OFFICE PROCEDURES

It seems clear that considerable improvement in operating efficiency could be effected throughout Government by introducing improved office equipment and methods. Typewriters, calculating machines, card files, billing and posting machines and similar equipment could be effectively used in many places where they are not now used, and would be a source of economy. Modern files and filing systems should be introduced. The various steps required in the work of each office should be analyzed, and office layouts and procedures arranged in such a way as best to facilitate the logical work flow. Progress in these matters will make for a more effective utilization and conservation of staff as well. A centralized pool of four or five messengers in a building for example, could serve fifteen individual officials fully as well as fifteen individual peons sitting outside their individual doors to respond to the occasional call of a bell, and could do so at far lower cost.

3. STATISTICS, ACCOUNTING AND REPORTING

The Preliminary Report stressed the importance of well-selected, comprehensive, reliable and timely statistics as an indispensable tool in the planning of economic development programs and their execution. It suggested the need for continuous effort to improve the statistical data available in Burma. It also stressed the benefits of full public reporting and financial accounting throughout Government. These recommendations continue to be of great significance to the effective organization and administration of the economic development program, and continuing efforts should be devoted to these problems.

F. THE PRIVATE AND MIXED SECTORS OF THE ECONOMY

Examination of how Government can improve organization and administration best to promote the execution of the economic development program must take into account what Government can do to improve the scale and efficiency of economic activity in the private and mixed sectors of the economy.

Although the Government must plan for all economic activity, it will not wish to plan all economic activity. It will certainly not wish to conduct all economic activity. Private enterprise, in the form of the individually owned business, the partnership, the corporation and the cooperative will exist and function. It will undoubtedly be dominant in many important sectors of the economy, such as agriculture, trade, various services, and small-scale or cottage industry; its participation will be desired in many other areas as well. Progress toward economic development goals will be facilitated if that significant part of total economic activity which is conducted in the private sector operates more efficiently than is presently the case. The same is true of public-private joint ventures.

The responsibility for achieving efficiency in private and mixed public-private enterprises rests in the first instance with the individual enterprises concerned. They must make a determined effort to modernize their equipment and production methods; to keep up with the latest techniques; to develop better labor relations; to provide better incentives to workers; to aim at larger sales volume and lower profits per unit; to improve their record-keeping and accounting, and analyze their costs; to develop the art of salesmanship; and to give better service to the public.

1. GOVERNMENT ASSISTANCE

Nevertheless, there are a number of ways in which Government can and should render assistance to such enterprises. Examples include the provision of cheaper fuel and electric power, and of improved transportation and communication facilities; the development of natural resources and basic industries to provide a greater variety of cheaper raw materials; the fostering of adequate and low cost credit; the provision of research and technical assistance; the elimination of unnecessary restrictions on business activity; the more expeditious treatment of business matters where restrictions or regulations are necessary; the establishment of standardized weights and measures; the provision of incentives to new investment, through the tax instrument and by other means; the inauguration of training programs to develop skilled technicians and workers; and, above all, the creation of an atmosphere of security and confidence.

Government should also, to the extent necessary, regulate private and mixed enterprises to insure that they operate in a manner conducive to the general welfare. Such regulatory activities will apply to minimum wages, healthful working conditions, collective bargaining, satisfactory and honest quality standards, truthful advertising, uniform and reliable weights and measures, competitive pricing, reasonable profits and the like. In a great many cases Government can better serve the general welfare by playing the role of umpire, by establishing the rules under which private production may be conducted, and by fostering the development of institutions which can assist producers, than by itself engaging in production.

2. CLARIFICATIONS OF GOVERNMENT POLICY

It has become clear that in a significant number of instances potentially desirable private economic activity has not been undertaken because the individuals or firms concerned were in grave doubt as to Government's policies in a number of matters. In some cases the chief question was whether Government would eventually nationalize the project concerned if it were undertaken. In others the question was whether Government would set up a competitive plant in the same field. In still others it was whether Government had sufficient interest to facilitate private development by granting visas for the technicians who would be necessary from abroad, by granting import licenses for the equipment that would be required, or by similar measures. Hesitations, doubts and fears of this kind have apparently deterred much new investment and resulted in lower levels of output, production, income and welfare than would otherwise have been the case.

In view of the many declarations which have been made in the past with respect to the industrial policy of the Government, beginning with the Constitution of 1948 and continuing through those declarations contained in the Two-Year Plan of 1948, the statements of the Prime Minister on June 14, 1949, and September 29, 1949, and in the resolution of the Economic Council in 1949, it may be asserted that private enterprisers have been afforded a clear statement of Government's position on these questions and should have no real doubts about them.

In spite of these statements, doubts do exist. Their existence suggests the need, first of all, for a restatement of the 1949 Resolution on Industrial Policy. This would be desirable for several reasons. The Resolution was adopted more than three years ago. Conditions have changed greatly in the meantime. The Resolution related primarily to foreign capital, but does not cover the important question of steps to mobilize indigenous capital. It is concerned only with industrial development and does not consider the encouragement of private and mixed public-private development in agriculture, trade, and other fields. Finally, it related primarily to the starting of new enterprises; only by implication does it refer to the need for encouraging expansion and modernization of existing enterprises. A restatement of the policy, expanded in scope as indicated above, and made as specific as possible, should be prepared. It should be disseminated widely both at home and abroad.

Such a restatement will not, however, be sufficient to allay fears and stimulate private investment. This effect can be achieved if Government will not only reaffirm and clarify its policies, but will also give evidence and assurance by its actions that it intends to implement these policies vigorously. Thus, the several government ministries and departments must be given to understand not only what are the Government's policies in this area, but how each agency and department of the Government is expected to contribute to the implementation of these policies.

In the area of new industrial development, for example, experience has shown that such specific practical questions as the following will be asked:

(1) How will *security conditions* affect lccation of the proposed factory? How will they affect sales as well as the smooth flow of raw materials?

(2) Can one get agreement from Government as to *non-nationalization* of the proposed plant for an agreed-upon period of years? Through what channels? How can necessary papers be expedited?

(3) How does one get prompt, responsible assurances as to freedom from *government competition* (especially on a non-full-cost basis) for a definite time?

(4) How will the proposed enterprise be affected by income, sales or other *taxes?* With whom may one discuss these points to obtain advance estimates necessary to help decide whether to establish the proposed enterprise in Burma?

(5) How does one go about requesting Government *loan or equity capital* participation? Does one apply in the first instance to the Industrial Development Corporation or to the Ministry of Industry? Are there forms to be filled in? Before one goes to the time and trouble to draw up a detailed application, with whom may one discuss the matter firsthand? Who actually makes the decision?

(6) In the case of a *joint venture or management contract*, what *terms* is Government likely to desire? Which responsible Government officials should one see for preliminary discussions?

(7) How can one without undue delay obtain *import licenses* for raw materials and equipment?

(8) If one can show that tariffs on raw materials or component parts are higher than on the corresponding finished articles, can one get *tariff relief* as an encouragement to manufacture finished products within Burma? Is there any quick standard procedure?

(9) Can one get assurance of *visas* for required foreign technical personnel? How can one avoid delays, sometimes of many months, in obtaining such visas?

(10) Can one determine in advance what proportion of their *salaries* it will be proper for candidates for such technical positions to *send home?* How?

(11) How, in cases where the enterprise is to be in whole or in part foreign capitalized, can one get a determination of the percentage of the proposed factory's *profits*, after taxes, *to be remitted abroad?*

(12) Where foreign participation is contemplated, may the foreign group send representatives to Burma for an on-the-spot *survey?*

Nobody would wisely establish or expand an industry in Burma without obtaining official determinations on such matters as listed above. In addition, any enterpriser is likely to face other problems on which Government can provide assistance. For example, Government should constantly be collecting, for a variety of industries, data on the following: markets; labor; raw materials; suitable technical processes; plant cost and amortization rate; and income, sales, and other taxes. Government should make such information freely available to indigenous and foreign enterprisers who are contemplating establishing plants in Burma.

If the Government wishes to expedite private investment in certain fields, it would be desirable to establish an "Investors' Bureau," with which a prospective investor can communicate or to which he can go in person to determine what the Government's general policy is concerning the field in question, and to learn where he must go to obtain answers to various questions such as those stated above, and what he can do to obtain prompt replies and decisions. Such an agency would be most effective if it aided the applicant in obtaining expeditious treatment of his problems by the appropriate ministries, and attempted to coordinate their consideration by, for example, aiding in speeding action by a ministry whose consideration was causing delay. The Bureau would of course have no administrative authority. Since its functions would be inter-ministerial, perhaps organizationally it might most appropriately be attached to the Economic and Social Board.

If the Government makes clear that it is not, in principle, hostile to private economic activity in spheres which Government has not reserved to itself, and if it indicates further that it welcomes the contributions which private economic activity can in the non-reserved sectors make to the economic development of the country (providing, of course, that the private activity is conducted in accordance with clearly established rules set up by Government to protect the general welfare), it may be anticipated with confidence that private economic activity will increase in volume and in efficiency. If so, it will contribute in major degree toward the realization of economic development goals.

G. SUMMARY OF RECOMMENDATIONS

MINISTRIES

(1) A thorough study of the responsibilities of the several ministries should be undertaken with a view to consolidation of responsibilities into a smaller number of ministries.

(2) The ministries should be internally reorganized so that in each case the minister and secretary will be at the head of a pyramidal structure with straight lines of command running from top to bottom.

(3) Each minister (or each one significantly concerned with the development program) should be provided with a deputy who will act for him when he is absent and who will shoulder some of his administrative load when he is present.

DEVELOPMENT CORPORATIONS

(4) The development corporations should be organizationally outside of the ministries, and should enjoy complete freedom in respect to day-to-day decisions. In respect to broad policy only, each may appropriately report to a minister.

(5) The development corporations must be bold and imaginative, willing to risk some errors for the sake of action. Bureaucratic caution is out of place.

(6) The development corporations should be delegated power to raise and to employ substantial sums of money before being required to obtain further financial authority.

(7) The internal structure of the development corporations should be carefully patterned in the light of sound principles of public administration.

(8) Staffing plans, to include locally available personnel plus such temporary foreign consultants as may be initially required, should be formulated for achieving early and significant increases in the staff available to the development corporations.

(9) To initiate new production or other projects, the development corporations should establish subsidiary public corporations, organize joint ventures, or employ other indirect means; they should not directly establish or operate such projects.

(10) Preferably through separate divisions established for the purpose, the development corporations should, to the extent indicated by basic government policy, encourage the establishment of new private as well as joint-venture and public enterprises, and the modernization and expansion of existing enterprises.

(11) For improved administrative efficiency, existing government production boards should be attached to, and made subsidiary to, the appropriate development corporation.

OTHER GOVERNMENT CORPORATIONS AND BOARDS

(12) Each existing government transport, marketing and regulatory board should be carefully studied from the point of view of its internal organization and procedures and its administrative relationships to the ministries with which each is affiliated.

GENERAL PROBLEMS

(13) The operating procedures and personnel requirements of each government agency should be reviewed. In many cases revision in office procedures is desirable.

(14) Every major executive agency of the Government should have a planning, progress reporting, expediting, and administrative improvement officer or unit attached in a staff capacity directly to the secretary or comparable executive, to initiate plans and integrate the agency's plans with the over-all program of the Government, to maintain progress reporting systems, to recommend measures to break bottlenecks retarding specific projects and to recommend administrative improvements designed to prevent the same delays from recurring.

(15) To expand and improve the training of public servants in Burma, courses in public administration should be established at the University of Rangoon (and at Mandalay College if maintained as a four-year college); the Ministry of Home Affairs should conduct public administration in-service training and research; and state scholars and mature government officials should be sent abroad for public administration study and practical observation.

(16) The Ministry of Home Affairs should regularly publish and disseminate bilingual announcements of all public service vacancies, the qualifications needed and procedures for applying; these should be exhibited in post offices throughout Burma. The Ministry of Home Affairs and the Ministry of Information should publicize the opportunities provided by government service.

(17) The same ministries should cooperatively foster the establishment of guidance programs at high schools, technical institutes, Mandalay College, and the University of Rangoon, with the object of interesting promising students in public service careers and of counseling them in respect to proper training for such careers.

(18) To stimulate recruitment and retention of qualified personnel, public service pay increases should be instituted.

THE PRIVATE AND MIXED SECTORS OF THE ECONOMY

(19) With the aim of clarifying its attitude toward private and mixed public-private economic

development, the Government should restate the 1949 Resolution on Industrial Policy. The restatement should make specific reference to the role of indigenous as well as foreign capital; should include private and public-private agriculture, trade and other fields; and should include existing as well as new enterprises.

(20) The major stimulus to desired private investment (including private participation in joint ventures and other mixed enterprises) must be action by the Government in rendering decisions concerning the many questions to which a prospective investor must have answers before he will feel assured that he can safely proceed. To expedite such action, the establishment of an Investors' Bureau to give information to prospective investors and to guide them to the appropriate officials is desirable.

(21) Other recommendations concerning personnel training, pertinent to government agencies as well as to other organizations in the economy, are made in Chapter VII.

CHAPTER VII

MANNING THE PROGRAM

A. THE PROBLEM OF SPECIALIZED MANPOWER

1. SPECIALIZED MANPOWER THE CRITICAL FACTOR

In terms of numbers of workers, Burma's manpower resources are more than adequate for meeting the requirements of the development program. Indeed, the fuller employment of labor is one of the broad objectives of the program. However, another and more profound objective, the employment of labor in a continuously more productive manner, will involve a serious manpower problem, in many ways the most serious economic problem to be faced for many years to come.

Burma possesses the other basic requirements for rapidly increasing output per worker employed: the adequacy of her natural resources in relation to the population and her ability to procure the necessary capital goods abroad. The situation is not as fortunate with respect to the third major factor, specialized manpower. The economic development program will generate needs for specialized types of manpower now either non-existent or very scarce in Burma. These include many kinds of professional personnel, technicians, skilled workers, managers and administrators. These persons will be needed throughout the economy, and especially in the fields of transport, communications, industry, power, mining, construction, irrigation, health, education and government. While the required number of persons of specialized skills and abilities will not be great in many of these sectors, it will in the aggregate be considerable, particularly in relation to the number of such persons presently available. It is this present and anticipated lack of specialized personnel which constitutes the critical manpower factor and the greatest obstacle to the development program.

The contribution which is made by specialized manpower—by managers and administrators, by scientists, engineers and other professional personnel; by skilled technicians; and by skilled workers—goes far beyond their individual roles in the productive process. Their importance lies even more in their ability to promote the productivity of other workers. The scientist in the medical research laboratory who develops a cure for a widely prevalent disease contributes thereby to the health and productivity of the entire labor force. The instructor in a technical or vocational training school who trains hundreds of machinists over a period of years makes a tremendous contribution to productivity and output in a number of industries dependent on such skills. The production superintendent in a factory who organizes and directs the work processes of a thousand workers with much higher efficiency than previously prevailed contributes in effect the equivalent of the output of a great many additional workers. Such examples, which could be endlessly multiplied, illustrate the tremendous importance of skilled manpower resources and dramatize their significance to the economic development program. Unless the needs for such persons are appreciated in their full significance, and unless adequate steps are taken to assure their availability in time, the fulfillment of the development program itself within the time contemplated will not be feasible. While skills and special abilities can be imported, it will not be feasible or desirable to meet more than a small part of the total needs for specialized manpower in this way. A major effort will be needed, therefore, to develop the necessary personnel within Burma.

The treatment of the problem of specialized manpower resources in this chapter relates to every segment of the economy and not just to the specific projects which are recommended in the Report. The analyses and proposals apply to agriculture as well as industry. They apply to existing enterprises as well as to new projects. The achievement of the aggregate goals of the development program rests necessarily on the assumption that improved methods, greater know-how, and better organization will gradually be applied throughout the whole economy. The problem of providing the specialized personnel who are the key to improved practices has, therefore, a very broad and general application.

Succeeding sections of this chapter will deal with this critical manpower problem in its several aspects: existing manpower resources, the requirements of the development program for specialized skills, and ways and means of satisfying those needs and increasing labor productivity in general. A special problem and the most difficult of all—that of top-level management—is dealt with separately in the concluding section.

2. EXISTING MANPOWER RESOURCES

The manpower resources in Burma were described in Section I of Chapter I. The known facts can be summarized briefly. Of an estimated population of 19 million persons in Burma about 45%—some 8·5 million—may be considered workers, i.e., members of the labor force. As compared to Southeast Asia generally, the population and labor force in Burma are small relative to land area and the country's resources. The bulk of the population, and therefore of the workers, is located in the broad southern deltas and in the main river valleys from the deltas northward to the region of Mandalay. Limited concentrations are also found in the deltas around Akyab and Moulmein. This river valley and delta population is predominantly rural and widely dispersed. This is even more the case with the remainder of the population inhabiting the horse-shoe of hills which surrounds the central region. The migration into towns which has accompanied war and insurrection has not altered significantly this basic pattern. The industrial work force which mans the few existing modern industrial enterprises is concentrated in Rangoon, and to a lesser extent in Mandalay and Moulmein.

About 5% of the population and a somewhat higher percentage of the labor force is composed of non-indigenous races—primarily Indians and, to a lesser degree, Chinese. In the past the proportion of non-Burmese workers participating in industry, commerce, transport and administration was higher than for Burmese workers. This was true of jobs at both ends of the economic scale. At the bottom of the scale this had the result of sparing the Burman from some of the least desirable jobs. At the top, the result was relatively little training and experience for the Burman in the tasks of an advanced economy. Now, both deliberate policy and prevailing attitudes assure that opportunities will be granted to indigenous races to overcome any handicap suffered in the past.

No recent comprehensive data are available describing the composition of the labor force according to workers' occupations or according to the industries in which they are employed. Occupational data will have to await the completion of the present census operations. Industrial employment data must await more complete coverage by the Directorate of Labor monthly surveys. The types of skills possessed by the population have received little statistical attention. The best available description of the Burmese labor force in terms of any of these three interrelated characteristics—occupations, industries, skills—is found in the 1931 census. The distribution of workers in that year according to a combined industry-occupational classification is shown in Table VII–1.

TABLE VII – 1

DISTRIBUTION OF WORKERS IN BURMA BY MAJOR CENSUS CLASSIFICATION, 1931

Major Census Classification of Workers	*Total Number of Workers (in thousands)*		*Percentage of Workers in Each Group*	
Exploitation of Animals and Vegetation		4,321·3		69·6
Ordinary Cultivation	4,009·1		64·5	
Special Crops	118·6		1·9	
Forestry	52·7		·9	
Animal Raising	79·9		1·3	
Fishing and Hunting	61·0		1·0	
Exploitation of Minerals		21·9		·3
Exploitation of Petroleum		17·6		·3
Industry (including Cottage Industries)		664·4		10·7
Textiles	233·2		3·7	
Sawyers	21·3		·3	
Metals	21·6		·3	
Ceramics	13·5		·2	
Chemical Products	18·5		·3	
Rice Processing	63·3		1·1	
Other Food Industries	78·2		1·3	
Articles of Dress	60·0		1·0	
Misc. Construction and Wood Crafts	101·5		1·6	
Misc. Industry	53·3		·9	
Transport		222·0		3·5
Water Transport	73·7		1·2	
Roads and Bridges	35·0		·5	
Road Transport	80·5		1·3	
Rail Transport	27·8		·4	
Other	5·0		·1	
Trade		557·4		9·0
Banks, Insurance, Brokerage, etc.	13·2		·2	
Textiles	18·8		·3	
Wood (excluding firewood)	14·9		·2	
Trade in Foodstuffs (incl. petty trade)	446·7		7·3	
Other	63·8		1·0	
Public Administration		49·9		·8
Professions and Liberal Arts		199·0		3·2
Religion	128·3		2·1	
Medicine (incl. unregistered healers)	29·1		·5	
Instructors	20·7		·3	
Arts, Sciences, Entertainment, Astrology, etc.	20·9		·3	
Domestic Service		44·7		·7
Miscellaneous		118·1		1·9
Grand Total		6,216·3		100·0

Although considerable changes have occurred since 1931 and the total labor force has increased, its composition as shown above no doubt remains essentially the same. It is dominated by peasant farmers, petty traders and handicraft workers. Although some of these workers possess a high order of skill, their skills are oriented to traditional and primitive methods of production. In the fields where modern enterprises, rice-milling and mining have been introduced the Directorate of Labor in June, 1951, accounted for only some 40,000 permanent workers in 475

TABLE VII – 2

NEW SKILLED MANPOWER REQUIREMENTS, PLANNED PROJECTS CLASSIFIED BY TYPE OF WORKER

*(Cumulative)**

	1953–54	*1954–55*	*1955–56*	*1956–57*	*1957–58*	*1958–59*	*1959-60*
Managerial and Supervisory							
Construction	382	484	583	554	516	472	454
Maintenance and Operation	0	47	135	351	456	510	583
Total	382	531	718	905	972	982	1,037
Professional							
Construction	430	525	580	585	554	508	496
Maintenance and Operation	0	20	50	103	145	159	192
Total	430	545	630	688	699	667	688
Sub-professional							
Construction	1,224	1,660	1,892	1,952	1,761	1,637	1,599
Maintenance and Operation	0	48	114	288	409	451	517
Total	1,224	1,708	2,006	2,240	2,170	2,088	2,116
Carpenters							
Construction	754	1,135	1,191	872	843	634	574
Maintenance and Operation	0	38	78	139	169	200	211
Total	754	1,173	1,269	1,011	1,012	834	785
Masons							
Construction	268	388	401	314	289	240	228
Maintenance and Operation	0	16	29	55	71	80	92
Total	268	404	430	369	360	320	320
Electricians							
Construction	378	553	546	456	435	400	420
Maintenance and Operation	0	31	124	267	361	442	509
Total	378	584	670	723	796	842	929
Machinists							
Construction	108	161	166	149	143	131	116
Maintenance and Operation	0	8	19	44	50	60	65
Total	108	169	185	193	193	191	181
Mechanics							
Construction	440	645	705	640	660	627	559
Maintenance and Operation	0	47	90	176	228	262	296
Total	440	692	795	816	888	889	855
Pipe Fitters							
Construction	313	518	576	517	516	460	439
Maintenance and Operation	0	16	33	61	75	98	121
Total	313	534	609	578	591	558	560
Foundry Workers							
Construction	93	146	152	146	151	147	144
Maintenance and Operation	0	8	18	37	45	51	61
Total	93	154	170	183	196	198	205

TABLE VII – 2 (*contd*)

(*Cumulative*)*

	1953–54	*1954–55*	*1955–56*	*1956–57*	*1957–58*	*1958–59*	*1959–60*
Smiths							
Construction	173	270	293	285	270	240	237
Maintenance and Operation	0	24	59	105	136	169	199
Total	173	294	352	390	406	409	436
Power Plant Operators							
Construction	124	209	219	202	196	172	171
Maintenance and Operation	0	11	22	71	81	109	132
Total	124	220	241	273	277	281	303
Processing Plant Operators							
Construction	0	0	0	0	0	0	0
Maintenance and Operation	0	25	122	522	560	700	705
Total	0	25	122	522	560	700	705
Drivers							
Construction	1,648	2,578	2,738	2,642	2,551	2,340	2,324
Maintenance and Operation	0	305	446	759	939	1,011	1,127
Total	1,648	2,883	3,184	3,401	3,490	3,351	3,451
Miscellaneous Skilled Workers							
Construction	135	229	241	208	235	208	205
Maintenance and Operation	0	22	80	211	274	318	339
Total	135	251	321	419	509	526	544
Total Skilled Workers							
Construction	6,470	9,501	10,283	9,522	9,120	8,216	7,966
Maintenance and Operation	0	666	1,419	3,187	3,999	4,620	5,149
TOTAL	6,470	10,167	11,702	12,709	13,119	12,836	13,115

*Figure for each year represents total requirements above 1952–53 level; figures for successive years are not additive.

establishments, which probably represented most of the larger ones. Even in the most advanced of these enterprises the technology typically has been kept as simple as possible, with an emphasis on brawn rather than skill for the great mass of the workers. The number of skilled personnel and their standards has always been very limited. Certain critical skills are almost completely lacking. Primarily these are the skills requiring advanced training and experience and falling into two broad classes: leadership (managers, supervisors, administrators of public institutions), and technical "know-how" (engineers, scientists, economists, highly skilled workers).*

There is, however, a brighter side to the picture. A small nucleus of skilled workers does exist, which can be utilized to fill the most critical jobs at present and to some extent to help train other workers. Literacy, which is necessary for maintaining administrative organization and for transmitting skills rapidly, is relatively widespread and increasing. There is no problem, for example, of staffing the large clerical civil service. According to the experience of large employers of labor, the Burmese national is adept at assimilating modern industrial skills.

The over-all situation, then, is one of a relatively under-developed labor force, but a labor force which possesses a potential for rapid upgrading.

3. FUTURE SKILLED MANPOWER REQUIREMENTS

In general there is no existing reservoir of unemployed skills nor, in the present state of economic activity in Burma, is there any considerable unsatisfied demand for skilled manpower. In the past ten years, emigration and the economic disintegration due to war and insurrection have depleted the ranks of skilled workers, caused deterioration of skills through disuse and retarded the previous rate of training of new workers. These same factors have also decreased employment opportunities. At the present very low levels of both supply and demand of skills, any disparity between them is negligible for planning purposes, and the two may be assumed to be in balance. Attention should therefore be directed primarily to the magnitude and nature of future additional requirements, and to ways of meeting them. In exceptional cases of surpluses, such as those of skilled sawmill employees, the workers can be absorbed by existing plants including those which are now closed down, and the demand for such workers is not reflected in the following estimates, which are based on *new* investment.

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*These classes overlap, as the best leadership material may have a "technical" background, but not all technical people need be good administrators.

Estimates of managerial, professional and skilled manpower required in the next seven years for projects in the fields of power, irrigation, industry, mining, transportation and communications specifically recommended in this Report are presented in Table VII–2 (*see p.* 96). The personnel required are shown by major work categories and by the sectors of the economy within which the projects fall. Requirements for workers who will construct plants and install equipment in them, and for workers who will subsequently operate and maintain the plants, are shown separately.

The requirements shown are for additional workers; workers who are presently employed in an enterprise which will execute one of the projects, and who will be available for work on the project, are not included. This is true, for example, on the Burma Railways, where only a fraction of the workers who will be needed on construction are shown on the table, because many workers presently employed by the Railways will be available.

For 1953–54, the requirements shown should be regarded as applying to the end of the fiscal year; materials and equipment will not be received in time to create demand for this number of workers before the year's end. For other years, the figures are annual averages.

The needs for skilled manpower resources will not be limited to those shown in Table VII–2, which reflect only the requirements for projects specifically recommended. Total investment in the various sectors of the economy will substantially exceed that in specifically recommended projects. It is necessary, therefore, to estimate requirements for skilled manpower which will reflect the needs generated by total investment in these sectors. Estimates have been made for the additional manpower requirements of each sector for the entire development program. While they have wide margins of error, they indicate the order of magnitude of the specialized manpower

TABLE VII – 3

NEW SKILLED MANPOWER REQUIREMENTS, ENTIRE DEVELOPMENT PROGRAM, CLASSIFIED BY TYPE OF WORKER

(*Cumulative*)*

	1953–54	*1954–55*	*1955–56*	*1956–57*	*1957–58*	*1958–59*	*1959–60*
Managerial and Supervisory	692	851	1,128	1,375	1,502	1,532	1,657
Professional	730	855	1,000	1,098	1,149	1,152	1,203
Sub-professional	1,824	2,328	2,716	3,040	3,070	3,018	3,166
Carpenters	3,754	4,773	6,469	7,411	8,612	9,184	10,485
Masons	1,268	1,654	2,230	2,619	3,060	3,320	3,620
Electricians	578	794	950	1,053	1,176	1,242	1,379
Machinists	168	231	261	277	280	281	281
Mechanics	640	902	1,075	1,136	1,223	1,239	1,255
Pipe Fitters	513	744	889	908	971	978	1,010
Foundry Workers	128	190	218	238	253	258	274
Smiths	248	372	457	510	531	539	586
Power Plant Operators	164	262	297	337	344	356	383
Processing Plant Operators	5	30	129	528	568	708	714
Drivers	2,348	3,723	4,294	4,746	5,070	5,121	5,431
Miscellaneous Skilled Workers	210	331	426	539	634	656	694
Total	13,270	18,040	22,539	25,815	28,443	29,584	32,138

*Figure for each year represents total requirements above 1952–53 level; figures for successive years are not additive.

problem. They are shown in Table VII–3. As in Table VII–2, they include only the additional persons needed. Allowance has been made for workers of each type who are now at work. It is believed that virtually no workers possessing these skills are now idle and available to meet the need for added workers.

The most important general conclusion to be drawn from this table is that it will be virtually impossible to meet the requirements indicated for the next several years. By the end of 1953–54, about 700 added managerial and supervisory personnel will be needed, more than 700 additional professional personnel, more than 1,800 sub-professional, and more than 10,000 skilled workers. The number of workers needed is much greater than the number now in training. To meet the requirements for many skills it would be necessary to go back several years in time to begin training the workers. To meet those at professional and managerial levels, it would be necessary to go back six to ten or more years in time to begin directing students into nonexistent courses of study and to begin giving necessary experience to young businessmen.

The significance of this fact is that management, professional abilities and skills will be the limiting factor in the progress of the development program. Unspecialized manpower and natural resources are available. Skills, professional training and management and every possible device must be used to economize on them. Foreign experts must be used liberally; sub-professional workers must be used wherever possible, saving the time of professional workers for guidance, management and purely professional analysis; and training must be accelerated in every possible way.

B. MEETING THE PROBLEM OF SKILL AND KNOWLEDGE

Taking into consideration the estimates of specialized manpower needs in 1953–54 to 1959–60, the means for developing the professional, sub-professional and skilled workers required are discussed in this section. Because of a number of special problems involved, meeting the need for top-level management will be separately discussed in Sections D and E of this chapter.

1. PROFESSIONAL WORKERS

The estimated needs for additional professional workers were presented in Table VII-3. The largest single group is engineers, but architects, physical scientists in a number of fields, lawyers, economists, statisticians and others will be needed. The number required is much greater than the number available.

Only a small part of these needs can be met by hiring foreign specialists. A maximum effort will be required to meet the remaining needs with indigenous personnel. Almost all professional workers require formal training at the University level, often including advanced study in Burma or abroad, or both.

a. University Training

Training at the University level is provided in Burma by the University of Rangoon with its affiliates, the University College at Mandalay and the newly opened Intermediate College at Moulmein, and the University for Adult Education. The latter has some 500 working people enrolled but the facilities for professional training are limited. The trends in registrations and the number of students completing work at the University of Rangoon, by major courses, for the past several school years are shown in Table VII–4.

TABLE VII – 4

UNIVERSITY REGISTRATIONS AND PASSES*

Course	*Number of Students Registered*			*Number Completing Course*		
	1950–51	*1951–52*	*1952–53*	*1950*	*1951*	*1952*
1. Intermediate (first two years for all students)	1,501	1,205	2,903	499	588	755
2. Intermediate, Mandalay	244	413	504			
3. B.A.; B.A. (Honors)	437	394	486	152	251	264
4. B.Sc.; B.Sc. (Honors)	230	266	310			
5. B.A.; B.Sc., Mandalay	45	59	79			
6. M.A.	68	102	126	8	12	11
7. M.Sc.	6	52	36			
8. M.B.; B.S.†	580	530	657	19	26	29
9. B.Sc. (Engineering)‡	229	294	321	—	15	34
10. B.L.	198	224	226	49	43	45
11. B.A. (Ed.); B.Ed; Diploma in Teaching	57	96	128	23	30	64
12. B.Com.	75	69	101	11	32	23
13. B.Sc. (Agriculture), Mandalay	25	30	22	12	9	13
14. B.Sc. (Forestry)	14	28	42	—	—	—
Total	3,709	3,762	5,941	773	1,006	1,238

*The available classification of the student body at the University College at Mandalay is in two groups, which are shown separately. No data are yet available for the Intermediate College at Moulmein which was opened in June, 1953.

†Bachelor of Medicine and Bachelor of Surgery.

‡Approximately two thirds of the engineering registrations and passes were in civil engineering; the other third was in electrical and mechanical engineering.

The rapid increase in the number of University students, which is now equal to more than twice the prewar enrollment, is encouraging. Even more significant, in view of the different type of personnel required by the future Burmese economy, has been the postwar shift in composition of the student body in favor of professional studies. Within the professional field the number of law students, who in the past dominated the professional field, has been relatively stabilized, and increasing numbers are studying medicine, education and engineering. The fact that there are still almost twice as many students in law as there are in education and two thirds as many as there are in engineering suggests that further movement in this direction is desirable. The reallocation of the student body, however, can only meet a small part of the increased requirements of trained professional personnel.

It is plain from a comparison of Tables VII–3 and VII–4 that, in all professional fields, the number of students trained and graduated every year will have to be substantially increased. The existing training facilities, which are already over-crowded in many respects, cannot accommodate many more students. The sending of students abroad is largely for purposes of advanced training of university graduates, and properly so; the net number of university trainees will be only slightly augmented. It is clear, therefore, that university facilities within Burma, especially for training specialized personnel, will have to be expanded.

Along with the need for increasing the numbers of young people training for these professions, the quality both of the students and of the professional training itself should be improved. Improving the quality of students entering upon the professions is a task which goes back to the very beginning of the educational process, at the primary school level, and which continues through the middle school and the high school. The quality of instruction at these levels must be improved and the courses of study must be modified to prepare all young persons for modern living and working conditions and to prepare some of them for advanced university studies. Other aspects of this problem are treated in a section of Chapter XXIV dealing with general education and other social services.

Adequate financial assistance should be provided throughout the educational process in the form of scholarships and stipends for needy students of promise. It should be possible for all Burmese youths of ability, both male and female, to continue their studies until they have had all the education which their intellectual interests and capabilities warrant. Such development will not only prepare them for a richer and more satisfactory life, but will also enable them to make a real contribution to the development of their country and people.

The problem of improving the quality of students in professional courses and of increasing their numbers as well has a forward-looking aspect also. More attractive rewards in the form of assurances of employment upon graduation and higher professional wage scales will have to be offered to prospective students to induce them to enter upon these fields.

In the natural course of events, these measures will induce many to seek professional education who are unqualified or who are not diligent students. Although existing facilities for such education should be greatly increased, they cannot be expanded indefinitely. Improvement in opportunities and rewards for professional education must be accompanied by positive steps to improve the selection of candidates for such education. Qualification for university work cannot be adequately established by a single formal examination, subject to passing by "cramming." A more comprehensive system is needed for weeding out from would-be entrants those whose preliminary training records and references do not give promise of satisfactory future educational and professional performance. Students in attendance at the university should be required to meet rather severe criteria of performance as a condition of continued study.

It may be possible by a series of related measures to expand the training facilities of the university, democratize the opportunities for university education, and apply rigorous standards of selection to students applying for entrance to advanced professional studies. Establishment of a number of intermediate colleges in the large cities, which would offer instruction only in the first two years of the university course, would provide an educational opportunity to many who are now deprived of it. It would also reduce the burden of elementary instruction at Rangoon, part of which is now inadvertently offered to students who are attending for reasons of social prestige, or who in any event are not qualified for studying further. The intermediate branch colleges could serve as training and testing grounds for advanced study, facilities for which could then be provided on a larger scale in Rangoon. Only the better graduates with acceptable grades and recommendations from the branch colleges would be admitted to the centralized "Upper Division" in Rangoon. For special reasons, advanced study in certain fields may be located elsewhere.

So far as improving the quality of university instruction is concerned, arrangements such as those already made between the University of Rangoon College of Engineering and the Massachusetts

Institute of Technology have produced encouraging results. Similar continuing arrangements for the training of local personnel abroad and for the provision of visiting instructors at the University of Rangoon should be made with other foreign universities in other fields, such as the natural sciences, agriculture, accounting, and statistics. Because of the more controversial nature of the social sciences, isolated exchanges with a series of foreign universities might be preferable in these fields of study.

b. Advanced Training Abroad

A continuing program of foreign study for qualified personnel is generally desirable because it assures that professional workers will be abreast of latest developments in their respective fields. It is especially necessary in those fields for which adequate training facilities have not yet been developed in Burma. To the present, for example, no one has undertaken foreign study in public administration; a few selected students should be encouraged to study in this field. The program of state scholarships to meet these needs has become well established and is supplemented by deputation for training abroad of members of the public service and by scholarships granted under the auspices of the United Nations, Colombo Plan, US Technical Assistance Administration, British Council Fulbright programs, the Massachusetts Institute of Technology agreement, and others. The available data on the magnitude of some of these programs, which may be somewhat incomplete, are presented in Table VII–5.

TABLE VII – 5

DEPARTURES FOR STUDY ABROAD, BY COURSES OF STUDY, 1948 to 1953*

Course	*1948*		*1949*		*1950*		*1951*		*1952*		*1953*†		*Total*	
	State Scholars	*Others*	*State Scholars*	*Others*	*State Scholars*	*Others*	*State Scholars*	*Others*	*State Scholars*	*Others*	*State Scholars*	*Others*	*State Scholars*	*Others*
Civil Engineering	—	—	—	1	1	3	4	1	2	8	3	3	10	16
Mechanical Engineering	2	—	—	—	1	—	3	—	3	—	2	1	11	1
Electrical Engineering	6	—	1	1	1	—	—	—	2	—	1	—	11	1
Communications Engineering	4	—	2	—	—	—	—	—	—	—	—	—	6	—
Mining Engineering, Metallurgy, Geology	3	—	1	1	—	1	3	1	4	—	3	—	14	3
Marine Engineering, Naval Drafting	3	—	—	—	2	—	2	—	3	—	3	—	13	—
Aeronautical Engineering	8	—	1	—	—	—	1	—	—	—	2	—	12	—
Chemical Engineering, Chemistry	2	—	—	1	—	1	5	2	3	4	1	—	11	8
Physics, Meteorology	1	—	1	3	—	1	3	—	1	3	—	—	6	7
Medicine and related subjects	6	—	2	—	4	5	4	2	4	27	7	9	27	43
Marine Officers' training	4	—	—	—	3	—	5	—	1	—	—	—	13	—
Civil Aviation (pilots, control officers, etc.)	5	—	5	—	4	—	—	—	6	—	—	—	20	—
Textile Engineering	2	—	—	—	1	—	—	—	1	—	3	—	7	—
Agriculture and related subjects	7	—	1	—	2	2	3	2	5	4	3	—	21	8
Forestry	1	—	—	2	3	2	—	—	2	6	—	1	6	11
Education	3	2	—	—	—	8	2	9	4	8	2	—	11	27
Commerce and related subjects	2	—	3	—	1	1	2	1	3	5	4	—	15	7
History, Anthropology, Sociology	—	1	—	3	—	5	2	7	7	3	1	1	10	20
Literature	—	—	—	3	—	—	—	2	—	1	—	—	—	6
Economics	—	—	1	1	1	1	—	2	1	1	4	—	7	5
Others	6	—	4	1	3	7	2	9	7	16	8	16	30	49
Total	65	3	22	17	27	37	41	38	59	86	47	31	261	212

*Under each year, the figures in left-hand column represent state scholars departed; figures in the right-hand column represent departure for study abroad under all other training programs.

†Data for 1953 are known to be incomplete. Those for other years may also not be entirely complete.

Full data would undoubtedly show that the number of trainees sent abroad reached its highest postwar level in 1953. The further expansion of this program is strongly recommended. The loss of the services of even a few outstanding persons for a year or more, when there is a general shortage of competent personnel, represents large short-term sacrifices. However, it is well worth while from the longer-range point of view because the training and experience which such persons can acquire abroad enhances their value over many years.

A stage has now been reached when it is necessary to improve the foreign training program qualitatively as well as quantitatively. This is particularly important in the case of the state-scholarship system, which encompasses by far the largest number of foreign trainees. The most important aspects requiring attention are the selection of scholars, the determination of appropriate training programs, and the treatment of returned trainees. From the standpoint of the country's interests, it is important that a systematic method be established for the placement of such returned trainees in positions where their talents can be utilized most effectively.

The entire process of selection, programming, and placement of scholars may be much advanced by designating a specially trained educator as counsellor for this purpose and providing him with a small staff. The advanced studies counsellor would assist those presently responsible for the advanced training program abroad by canvassing promising graduates and other individuals to assure that the best qualified become candidates, by making a careful study of the qualifications of candidates, by advising on the most appropriate institutions and curricula for various courses of study, by arranging to keep in contact with the progress being made by students abroad, by obtaining full references on their achievements and ability on the conclusion of their training, and by assisting in channeling the trainees on their return into the positions for which they are best qualified. With the aid of such a permanent staff, the over-all planning of the foreign training program also could be improved. This would include systematic determination of the needs and priorities for types of personnel who require foreign training, full exploration of the many foreign and international scholarship opportunities available, and investigation of possibilities for on-the-job training to supplement and in some cases replace academic study.

c. Hiring Professionals Abroad

For some years to come, it will be necessary to engage a number of professional personnel from abroad to overcome domestic shortages and to help train Burmese nationals. Some of these will continue to be provided through the United Nations and other technical assistance programs. Some will undoubtedly be brought in by firms to whom management contracts will be awarded, particularly in the industrial sector, while many other professionals may be engaged as individuals. Whereas until now a number of foreign experts have been engaged to study and evaluate particular problems and situations and to develop plans and programs for dealing with them, the foreign experts who will be required in the future will be needed increasingly for operating purposes, namely, to execute plans and to implement development programs. Such personnel will be required for substantial periods of time and will have to work closely with Burmese nationals on a day-to-day basis somewhere below the top policy level. In engaging these personnel, it should be kept in mind that the qualities needed involve more than high standards of professional competence and experience. These individuals should also have sufficient flexibility to adapt themselves to working conditions in Burma, and attitudes which are basically in sympathy with the aspirations of the Burmese people. Individual assignments and responsibilities should be closely designated, and organized plans should be made for the prompt orientation of such personnel upon their arrival in Burma, including the provision of necessary information, staff and facilities, so that they can make their maximum contribution during their period of service. Their use to train Burmese nationals in the process of their work in Burma is important.

2. SUB-PROFESSIONAL WORKERS

Table VII–3 shows that 3,166 additional sub-professional workers will be needed during the next seven years. In this group are included sub-engineers, surveyors, draftsmen, supervising mechanics and supervising electricians, who require a fairly considerable formal training, though not of the extended and costly university type. The fact that under proper supervision they can do a great deal of supervisory work which would otherwise need to be done by graduate engineers and other professionals lends a special importance to this group.

Existing training facilities for such personnel are concentrated in the Technical Institute at Insein. The prewar Government Technical Institute at Insein was re-established on a permanent basis in 1951 for the training of sub-professional personnel. It offers three-year courses in civil, mechanical, electrical and communications engineering and in civil engineering drafting. Because the Government Technical Institute is the only existing institution for the formal training of sub-professional workers, and because of the extremely important role it must play in preparing such workers for the development program, a rather detailed discussion of the situation with respect to the Institute and its problems is appropriate.

The Technical Institute occupies several acres of land off the main road at Insein. It has a number of excellent buildings among which the main building, designed for lectures and laboratories, is outstanding. It has living accommodations in a separate building for some 130 students. With a slight degree of crowding, 150 second- and third-year students are presently accommodated. It is anticipated that the entering first-year class will add 110 to 120 new students. In addition to the buildings mentioned, there are also several workshops, three faculty houses and a number of storage and service buildings.

Instructional equipment and aids, both in the laboratories and in the workshops, are seriously lacking. The library is also seriously deficient. TCA had allotted $190,000 for basic equipment requirements. However, since this program had not reached the stage of procurement at the time TCA aid was terminated, other means will have to be found to procure this and other needed equipment.

At the present time the instructional staff consists of two lecturers, four instructors and a number of workshop demonstrators. A minimum of 11 additional lecturers and instructors is stated to be required to serve the present student body plus the entering class. Sanctions exist for additional staff, but it is reported that competent teachers cannot be hired at existing salary rates. One of the present staff will soon transfer to another government position which is more remunerative. The Director of Technical Education has recommended that the monthly salary scales be increased to K600–40–800 plus CLA for lecturers (nationals and non-nationals), K350–25–700 plus CLA for assistant lecturers (*ad hoc* K500 for non-nationals), and K330–15–450 plus CLA for instructors (*ad hoc* K400 for non-nationals). It is reported that at the salary scales recommended it will be possible to engage the necessary staff either within Burma or by recruiting in India. At the present time some scheduled classes for second- and third-year students are not meeting because staff is lacking. The morale of the student body and of the staff is seriously threatened by this situation, which will be aggravated when the first-year class enters.

Students who have completed high school or passed matriculation examinations may sit for entrance examinations to the Institute. Beginning with this year entrance examinations are to be held in major cities throughout Burma, rather than in Rangoon alone. No tuition fees are charged for attendance at the Institute. Stipends are awarded to half the present students, on the basis of scholarship rather than need. Living accommodations are provided free of charge. Students themselves supervise the provision of food for which each student contributes K40 per month. The students seem to be reasonably well prepared for, and interested in, their courses of study. Over 40% of the students are enrolled in the civil engineering course.

It seems clear that the Technical Institute at Insein represents a magnificent potential for technical training. In view of the acute need for technicians, plans for getting the Technical Institute functioning properly should be aimed at the largest possible student body. Existing classroom and laboratory space can accommodate a much larger student body than is now enrolled. However, expansion will entail a larger faculty than the 17 lecturers and instructors contemplated, more equipment than would be provided by the $190,000 program previously envisaged, and additional workshop space. It would require also the provision of student living and dining accommodations over and above those presently planned, which would increase hostel capacity only to about 350. In this connection, however, it may be noted that approximately 40% of the students at the Institute come from the Rangoon area, and pending solution of the hostel problem these might be required to become day students only, with provision made for their daily transport to and from the Institute.

It will not be difficult to solve these problems if procedural administrative log-jams can be broken. It would be unfortunate if remedial action were delayed further. Vigorous efforts should be made to obtain the necessary finances from available contingency funds as soon as possible, and to press forward with the necessary program. It is understood that the problem of appropriate pay scales for lecturers and instructors presents an unusual difficulty because it is related to comparable problems throughout the various government departments. In view of the crucial role of the Institute in providing trained personnel for the economic development program, it is urged that every effort be made to solve this difficulty apart from the more general problem of government wage scales. The service which the Institute can perform is so important that reluctance to exceed pay scales for what are regarded as comparable personnel elsewhere should not stand in the way of salary increases.

It seems plain that the Government Institute at Insein, even when operating at full capacity basis, will not be able to provide all the trained technical workers needed. At least one or two additional institutions for technical training will be required elsewhere. Under the circumstances, however, it is considered expedient to recommend that all available energies be concentrated on realizing the potential at Insein before attempting to develop additional formal training facilities in other cities. It will be desirable, however, to supplement the formal training of sub-professional workers at Insein to the greatest possible extent by in-service training courses, conducted by the various government departments and agencies, as recommended in Chapter VI, and by the larger private employers. In many cases, both formal and in-service training should be augmented by advanced training abroad.

3. SKILLED WORKERS

Table VII–3 shows an estimated need for some 26,112 additional skilled workers during the period of the development program. Among this group are included such workers as carpenters, electricians, masons, machinists and mechanics. Some types of skilled workers can be trained on the job, provided that competent foremen are available to supervise their work and provided that a nucleus of such workers exists alongside whom the novices can work and learn. However, some of these workers will require formal training. This will be especially true of those who will need to qualify as master mechanics, tool makers and group or crew supervisors.

Existing facilities for the training of skilled workers are represented chiefly by the Artisan Training Center, established in Rangoon in 1948, and by the training project of the Rehabilitation Brigade at Insein. Some equipment and staff have been mobilized for a projected artisan training center at Mandalay, which now awaits the construction of workshop buildings. Centers for Moulmein, Akyab, Myitkyina and other cities are intended.

a. The Artisan Training Center

The Artisan Training Center in Rangoon offers courses of two years duration in nine basic trades: carpentry, electricity, radio, motor vehicles, machine shop, foundry, diesel engines, fitting and welding, and blacksmithing. The instruction is essentially practical in nature, but includes rudimentary theoretical training as well. Stipends of K30 and K40 per month are granted to first- and second-year students respectively. Approximately 20 students per course, or a total of about 180 students, can be accommodated. At the present time 106 first-year trainees and 37 second-year trainees, or a total of 143 students, are enrolled. The relatively small number of students in the second year of training is typical of past enrollments and reflects the fact that a very high proportion of entrants do not complete their course. The number of admissions, graduations and drop-outs in each of the past classes is shown in Table VII-6.

TABLE VII – 6

ADMISSIONS, GRADUATIONS AND DROP-OUTS AT THE ARTISAN TRAINING CENTER

Class entering in	*No. of Trainees Admitted*	*No. Completing Course*	*No. Not Completing Course*
February, 1948	55	15	40
June, 1948	116	55	61
January, 1950	93	24	69
July, 1950	57	19	38
September, 1951	170	42	128
Total	491	155	336

Only 155 trainees have graduated from the Artisan Training Center in Rangoon in its five years of operation. More than twice this number of trainees have dropped out of the school before completing their training courses. This high drop-out rate is due to a number of causes. In some measure student registrations are exploratory and students soon drop out because they discover either that they have no real interest in the craft or because they are dissatisfied with the instruction and equipment, both of which are of varied quality. In some cases students drop out of school because they find jobs which are more attractive or because they find the stipends inadequate. Vigorous efforts should be made to improve the quality of instruction and equipment, to interest more youths in vocational training instruction, to select and guide students into training for which they have aptitude and interest, and to place students in good jobs upon completion of their studies. The inadequate staffing of the Directorate of Technical Education, plus the more obvious and pressing needs for sub-professional workers, has led the Directorate of Technical Education to concentrate its energies on the Technical Institute at Insein. It is necessary, however difficult the problems posed, to move forward also with the Artisan Training program both in Rangoon and elsewhere.

b. The Rehabilitation Brigade

A program of training in skills is being carried out by the Rehabilitation Brigade at Aung San village, 13 miles from Rangoon. Some 3,000 members of the Brigade are located there at present. They are provided with free housing and a stipend of K80 per month. All members of the Brigade, and many of their wives as well, receive training in technical and vocational subjects. A number of large, well-planned and well-equipped training shops have been installed, with a heavy emphasis on woodworking and metalworking skills and the construction occupations. The scope of training is gradually being expanded towards the goal of some 25 subjects to be offered to about 4,000 trainees per year. The investment in plant and equipment is very substantial. Approximately K2·5 million worth of equipment alone has been procured to date. The instructional staff comprises some 72 personnel, including workshop demonstrators. The facilities are intensively used, with half of the Brigade members at Aung San village receiving instruction in the morning and the other half in the afternoon. The instructional plan calls for six months of such training during each of the two years of minimum enrollment. The remaining time is spent acquiring on-the-job experience in organized production work outside the camp.

This project is inspiring. It is well organized and dynamically directed. Efforts have been made to organize courses of study systematically and to develop training manuals and instructional aids. Its scale of operations is such as to suggest quite strongly that the major contribution to formalized training of skilled workers in Burma in the coming years will be made by the Rehabilitation Brigade.

Membership in the Brigade is open, not only to ex-insurgents, but also to unemployed and displaced youth. The disposition of trainees, once they have completed their courses of training—employment on organized production or release to private or other public employment—has not been finally determined. In either event, of course, the contribution being made is of great significance to the economic future of Burma. It is suggested, however, that to the extent feasible the excellent facilities for training at Aung San village be made available to non-Brigade members who upon completion of their training could flow into whatever areas need their acquired skills most acutely.

c. Other Training Programs

Training in handicrafts and small-scale industrial processes is primarily the responsibility of the Office of the Superintendent of Cottage Industries. In 1952–53, about 30 students were enrolled in a three-year course at the Lacquer School at Pagan and some 50 students in a two-year course at the Saunders Weaving Institute at Amarapura. Twelve recently obtained power looms are now being installed at the latter school, and a three-year course in power-loom weaving will be started by a United Nations technical assistant for selected graduates of the hand-loom course. In 17 different districts one-year courses are given in District Weaving Schools, selected graduates of which make up the trainees at the more advanced Saunders Institute. Traveling demonstrators give advice and training in spinning, weaving and dyeing to operating establishments throughout Burma.

The Superintendent of Cottage Industries is responsible for initiating training and advisory programs in other special branches of small-scale industry and for coordinating the work in this field of 11 United Nations technical assistants, most of whom arrived in the past year. A training program in textile printing at Rangoon aimed at improving the quality and design of work by introducing new techniques is firmly established. Two eight-month classes have already been graduated, the last one consisting of 18 students. Twelve students have almost completed a course in sericulture at the new mulberry farm at Maymyo.

Detailed plans have been made and equipment has been ordered and some received for training centers—in some cases complete pilot plants—in the silk-reeling, pottery, handmade paper, sugar refining and condensed milk industries. On-the-job advice to existing enterprises is already being given in some of these fields. A United Nations and a Burmese expert are also advising silk weavers on patterns and dyes, and two additional United Nations technical assistants will arrive soon to extend this program to the woodworking and electroplating and anodizing industries. The importance of these brief orientation classes for limited numbers of trainees and of on-the-job advisory programs is enhanced by the fact that they are oriented to the immediate practical needs of the industries and to persons already working or about to be working in them. Thus, for example, some 15 printers who attended the textile printing classes already have introduced the new screen-printing process in their establishments, and the sericulture trainees will be used for instruction and other work in implementing the three-year program for self-sufficiency in silk production.

Two small vocational handicraft schools are under the administration of the Director of Technical Education. The Polytechnic School occupying two rooms at the Government Technical Institute teaches leather-tanning and leather-working to about 25 students from the Rehabilitation Brigade. Another 25 youngsters receive training in bookbinding, toy-making, and cane and bamboo work at the Handicraft School located in the compound of the Rangoon Artisan Training Center.

The Adult Education University provides a learning opportunity for some 400 working adults. Engineering Technology evening classes, which have been suspended for lack of classroom space, will be resumed at the Artisan Training Center when additional buildings now under construction are completed. The two-year course of training, meeting three nights a week, had been attended by some 250 students.

4. ORGANIZING AND ADMINISTERING THE TRAINING PROGRAM

Training of professional personnel is sufficiently distant to warrant its own organization structure. In so far as such training is performed in Burma, it of course falls under the separate administration of the University of Rangoon. The responsibility for administering the major foreign training program, state scholarships, is shared by the Ministry of Education and a special selection board. Comments on the organization and administration of professional training were included in Section B–1. As concerns training of sub-professional and of skilled workers, two special problems which are common to both of these programs are discussed in this section.

a. Central Responsibility

Responsibility for organizing, administering and executing the technical training program is vested in the Directorate of Technical Education within the Ministry of Education, to which it was transferred from the Ministry of Industry in 1952. Responsibilities for technical training have also been vested in the Industrial Development Corporation and the Mineral Resources Development Corporation. As of the present time, arrangements for cooperation between and coordination of the efforts of these bodies do not seem to have been developed. Similarly, such coordination and cooperation do not seem to have been developed *vis-à-vis* the Rehabilitation Brigade. It is recommended that such arrangements be made by means of an advisory board on which all interested agencies would be represented.

In the Preliminary Report it was noted that "an organizational problem which merits serious consideration is whether the Directorate of Technical Education should reside within the Ministry of Industry or within the Ministry of Education." It now appears that important practical grounds exist for moving the Directorate of Technical Education from the Ministry of Education, where perhaps on strict grounds of organizational theory it should find its home. The responsibilities of the Ministry of Education are both comprehensive and varied, and it is unreasonable to expect that harried officials confronted with a multitude of problems on every educational front can devote to the specialized program of technical education the full measure of attention and energy it requires. Moreover, these other broad commitments of the Ministry of Education in their very nature frequently act as obstacles to the special efforts required for promoting technical education. For example, the disinclination to award higher pay scales to technical teachers results from a concern with comparative salaries throughout the educational system. Yet only a relatively few technical teaching positions are involved, and the importance of filling these positions is so critical to the whole development that special consideration is essential.

The problems of technical education will be solved more expeditiously if ultimate responsibility is placed either in a ministry more immediately concerned with this problem, or in an agency concerned exclusively with this problem. The responsibilities of the Ministry of Industry tend to make it acutely sensitive to the needs for technical and skilled workers, and it is anticipated that this awareness would result in treatment of the problem on a top priority basis. It is suggested, therefore, either that the Directorate of Technical Education be moved back to the Ministry of Industry or that an autonomous board for technical education and training be constituted and assigned responsibility for developing and executing the necessary programs.

b. Developing Teachers of Vocational Training

The number of qualified instructors available for training sub-professional and skilled workers is highly inadequate to present needs, and will be even more seriously deficient as training programs are expanded. In the long run, the situation will tend to correct itself. For the short run, however, it will be necessary to employ a number of expedients.

To augment the personnel available as lecturers and instructors in the training of more advanced technicians, it will be necessary in many cases to engage staff from abroad. Efforts should be made to enlist the services of engineers who have retired from gainful employment, and to enlist the part-time services of engineers presently employed in the various government departments and in private employment as well. Encouragement should be given to the further development of and increased participation by national professional societies (especially engineering and educational) in solving these problems. Such private bodies could be of real assistance both in mobilizing aid and in providing valuable advisory services to all agencies engaged in training.

Teachers of skilled workers must be drawn in the main from two sources—from the sub-professional technician group and from the artisan class itself. The number of technicians who will be available to serve as teachers of vocational training will be limited by competitive demands from the various government departments and from industry. Such persons might be readily available for part-time service as instructors in courses conducted in the evening. There is no reason, moreover, why the skilled worker class itself should not be able to yield a considerable number of instructors and workshop demonstrators for artisan training classes. It will be exceedingly important, however, that some in-service training be provided for such artisan instructors to convey to them the basic pedagogic principles and practices which will enable them to impart their artisan skills more effectively.

5. IN-SERVICE TRAINING: A CENTER FOR TRAINING AIDS

The discussion above has dealt almost entirely with training before the worker enters upon his job. Another important aspect of training is training while in service. For many lower-level workers, in-service training is more effective than formal pre-job training, and completely takes its place. It is also important for all of the levels of workers discussed above. No employee at any level is completely prepared for a new position when he enters upon it; an important part of his training is what he learns on the job. His learning on the job may be haphazard and accidental or planned and organized. Organized in-service training can greatly accelerate both the approach to peak effectiveness by a worker and his preparation for moving to higher-level positions.

Many of the larger business organizations in Burma, both governmental and private, have had their own training programs for many years. Not enough study has been given to the individual programs to make specific comment useful. Organized in-service training should be introduced not only into the new productive enterprises to be established, but into virtually all existing government agencies which do not now have it. It is as important in government administrative agencies as in business-type enterprises.

While the specific type of training will vary greatly from agency to agency, there will be many elements in common. Many devices learned by the governments and business enterprises of belligerent nations during World War II, in their attempts to accelerate their greatly expanded needs for specialized manpower, can be applied in Burma. It is recommended that a Center for Training Aids, attached to the Ministry of Home Affairs, be established, one of whose main functions should be to advise every agency of Government concerning means of expediting effective worker orientation and in-service training. This advice should relate to training pamphlets, audio-visual aids, orientation courses, refresher or improvement courses, accelerated apprenticeship schemes, teacher-learner squads, and a variety of other methods and aspects.

The Center will be of little use without the right head. In-service training, done by rote because it is said to be good practice, can be a waste of time and in fact a means of dulling enthusiasm. Only under a leader who has seen accelerated training at work in offices and shops and has the imagination to appreciate its possible applications in varied circumstances in Burma will the work of such a Center be fully fruitful.

6. PREPARING A COMPREHENSIVE PROGRAM FOR TECHNICAL TRAINING

While an attempt has been made to present a useful statement of the situation and problems with respect to training of sub-professional and skilled workers in Burma, and to make helpful recommendations concerning them, it has not been possible to explore fully all the considerations and data involved in the preparation of a comprehensive training program. It is urged that further and continuous study and consideration be given to the preparation of a comprehensive program in this most significant area. The Government might establish a commission or engage experts for this purpose. It could also invite foreign technical assistance, whether international or privately endowed in nature, for advice in this field.

C. MEETING THE GENERAL PROBLEMS OF INCREASING LABOR PRODUCTIVITY ON THE JOB

The many broad factors which influence labor productivity in general are outlined in Section C of Chapter II. In a real sense, this entire Report is concerned with bringing these influences to bear in the Burmese economy. Within the field of manpower considerations, the special problems of developing the necessary professional, sub-professional and skilled personnel have been defined and measures for their solution have been recommended. There remain certain aspects of labor productivity which have to do with workers as such, as distinguished from more comprehensive factors such as health, which affect all citizens but which are equally applicable to all workers, specialized or non-specialized. An analysis is required of the factors making for increased productivity and output on the job—what may be called, in short, management-labor relations.

Those aspects of management-labor relations which bear most significantly on labor productivity and output are the earnings and hours of work; such related conditions as holidays, vacations, sick leave, pensions and similar benefits having monetary value; non-monetary conditions of work such as tenure, seniority and physical comfort on the job (cleanliness, light, heat, sanitation, protection against hazards, etc.); the arrangements which exist for management-labor cooperation and bargaining (such as union contracts, grievance machinery and the like); and finally the very "atmosphere" of work itself, which is a sensitive complex of a number of factors both tangible and intangible affecting the worker's morale and discipline, and which can make him either a sullen and resentful cog in a machine or an eager and cooperative worker in a purposeful group.

1. EARNINGS AND HOURS OF WORK

Earnings and living standards throughout the Burmese economy are low, not only in relation to the standards of more highly developed countries, but also in relation to the wage levels which can be achieved in Burma. They vary considerably between industry and agriculture, between one geographic region and another, between large and small establishments, and between higher and lower skills.

Adequate data do not as yet exist for the precise measurement of incomes throughout the economy. These can be more accurately measured for the relatively small groups of workers who are employed by the larger trading and industrial enterprises and on major government projects. A brief study made by this survey group indicates that the average value of wages and cost-of-living allowances received by production workers in such enterprises, on the basis of a 44-hour week, is approximately 110 kyats per month. This finding is supported in a general way by the calculations of the Directorate of Labour which indicate that the average incomes of permanent workers for all industries listed in the latest tabulations (except banking and air transport, which are special cases) is 117 kyats per month. Typical rates of pay for ten major occupational groups based on information received from 14 large employers of labor are presented in Table VII–7. These show that unskilled laborers in such selected enterprises, which must be presumed to be relatively better paying than others, averaged about 80 kyats per month; semi-skilled workers averaged about 110 kyats per month; and skilled workers averaged about 180 kyats per month.

The need for higher incomes for Burmese workers with which they could better provide for the basic requirements of living such as health-maintaining food consumption, decent and sanitary housing, and necessary clothing and for education, recreation, transportation, vacations, insurance and other essentials of everyday life is universally recognized.

It has been repeatedly emphasized throughout this Report that in the long run the standard of living and the welfare of the Burmese people will depend on the total output of goods and services which can be achieved, which in turn depends on the amount of work which is performed and on the efficiency or productivity of that labor.

TABLE VII – 7

TYPICAL MONTHLY RATES OF PAY IN LARGE INDUSTRIES, BY TEN MAJOR OCCUPATIONAL GROUPS (44-HOUR WORK WEEK)

Occupational Group	*Wages Plus Cost-of-Living Allowance (Kyats)*
Engineers	880
Assistant Engineers	500
Senior Foremen	380
Lower-level Foremen	270
Administrative Workers; highest level	470
Administrative Workers; intermediate level	270
Administrative Workers; low level	180
Skilled Laborers	180
Semi-skilled Laborers	110
Unskilled Laborers	80

Individuals and organized economic groups frequently have a disposition to think that their standard of living can best be raised by striking a better bargain with their employer. This, of course, may at any given time be the case, although very often when a group of workers succeed in obtaining an increase in pay, this increase is paid in reality not by their employer but by the rest of the population, in the form of higher prices for the goods or services produced. The effect of the pay increase in such case is for the standard of living of the small group immediately involved to be increased, at the expense of a decrease in the standard of living of the much larger group who consume their product, many of whom, although they may be especially needy or deserving, are not in a position to press for pay increases.

The intention of this analysis is not to dissuade workers, whether individually or in groups, from seeking to improve their living standards through bargaining with their employers; indeed, such bargaining is one of the ways in which the benefits of increased productivity are allocated in a democratic society. The objective of this analysis rather is to emphasize that in the long run real and substantial increases in the living standards of all the Burmese people can be achieved only through substantial increases in the total production of goods and services.

With special reference to the so-called industrial "wage workers," who constitute most of the non-self-employed workers in industry, it would not be practicable in general to increase wage levels in Burma at this time. The effect of such increases at current levels of production could only be to increase costs and selling prices and achieve gains in the living standards of the favored groups at the expense of the living standards of other working groups and perhaps of the cultivators. It would be more practicable to provide monetary incentives to increased productivity and output. There are in general two ways in which this can be done. One is by associating current levels of workers' output with the current wage, and of providing extra wage bonuses for units of output in excess of the current level. The other method is by providing a share in the profits of the enterprise for the workers. Both methods have been practiced in advanced economic societies, and both have been productive of extremely worthwhile results. Is is suggested that these methods have real possibilities for increasing productivity and living standards concurrently.

With respect to the hours of employment, at least so far as the larger industrial and trading enterprises are concerned, the comparison with other countries is quite different. The standard week has been established at 44 hours on a five-and-a-half-day basis. This compares quite favorably with the hourly conditions of work in other advanced countries. In fact such countries did not reduce working hours to this level until they achieved standards of productivity much higher than now exist in Burma. Because of cultural factors and the general advance in conceptions of workers' welfare, it would be a mistake to attempt to lengthen working hours beyond 44 hours per week. However, the elementary facts of the economic situation in Burma indicate that it would be equally a mistake to attempt to reduce the work week below this level until a very substantial increase has been effected in productivity and total output by the economy. Wherever feasible, work weeks which are now far below this level as in the government service should be increased at least to about 40 hours. Such a reform is most expeditiously initiated when a corresponding pay increase is also justified. The special justification for pay increases in the important government sector of the economy is discussed in Section E of Chapter VI.

2. MONETARY FRINGE BENEFITS

In some respects prevailing benefits of this category are quite advanced in Burma. It is reported, for example, that in the larger establishments referred to above, typical arrangements include 17 paid holidays per year, two to four weeks of paid annual leave, 60 days or more of paid sick leave, and occasionally ten days of additional paid "casual" leave per year. The liberality of these standards (however limited in application they may be) may be judged by the fact that in the highly developed United States economy, powerful labor unions have achieved, for their members who work in industry, no more than seven to nine paid holidays per year and two weeks vacation with pay (although in some cases three and even four weeks of paid vacations are granted to workers who have been on the job five or ten years). In further sharp contrast, allowance for sick leave with pay to industrial workers is virtually non-existent in the United States, and additional paid leave for such workers on grounds other than those already mentioned is non-existent. On the other hand, old age pension schemes and protection against unemployment have developed remarkably in the United States in recent years, both through legislation (which embraces widows' and orphans' pensions as well) and on a private basis through collective bargaining. Desirable as these forms of protection for workers and dependents are, their introduction on a major scale in Burma will become feasible only when substantial increases in productivity and output have been realized.

3. NON-MONETARY CONDITIONS OF WORK

With comparatively few exceptions, the physical conditions of work in Burma are far below minimum levels of acceptability. Improvements must be made in terms of cleanliness, sanitation and elementary creature comforts if real gains of labor productivity are to be achieved.

The introduction of machinery and industrial occupation in other countries in the past has been attended by a high accident rate due to failure to provide adequate safeguards against occupational hazards. Such safeguards are absent in the great majority of establishments in Burma. Burma should not wait to experience first a large number of industrial accidents, but should take timely measures to prevent them at the very outset of her industrialization, by means of rigorous standards for safety devices and a thorough system of governmental inspection.

Other non-monetary conditions of work which promote workers' productivity are security of tenure on the job and fair treatment in the granting of promotions. These assurances must be provided by a system of seniority rules which will protect the interests of ordinary workers, promote incentives to better performance, permit the more qualified to advance more rapidly, and at the same time prevent the creation of sinecures for the idle and incompetent. Because the requirements of different working situations vary so much, the difficult task of devising an appropriate system is best accomplished by agreement between the management and the workers' organization in individual establishments or enterprises. The Government, in addition to its responsibilities for public workers in this connection, may properly also lay down broad basic rules providing minimum protection to all workers. Its general function, however, should be to provide advisory, conciliation and arbitration services and in other ways to promote private agreements.

4. ORGANIZED RELATIONS BETWEEN LABOR AND MANAGEMENT

A continually functioning system of organized relation between management and a workers' organization is, in general, the most effective method for attacking most of the issues discussed above. Labor organization in Burma has until recently been in the "growing pains" stage. Now, with 70,000 workers in trade unions, the point has been reached when labor organizations can make an important contribution to the welfare of the country at large, while at the same time protecting and advancing the interests of their members to a greater extent than before. The many and varied functions which trade unions can perform in the social and cultural fields as well as in the economic area are too well known to warrant their enumeration and discussion here. The greatest single obstacle to the fuller performance of these functions by the Burmese labor movement of today is the absence of permanent and systematic working relations with management cooperatively arrived at and resulting in formal and binding agreements. Unilateral offers and demands by employers and trade unions, often arbitrated by governmental decrees, generally take the place of collective bargaining in the true sense of the word. Frequently there is a total absence of discussion and negotiation before a matter is carried to the point of arbitration or the calling of a strike. Not only are the final outcomes of such proceedings apt to be unsatisfactory to all concerned but the very technique of arriving at them breeds distrust and suspicion. These in turn lead to open violation of agreement or more subtle disruption which is equally fatal to efficient production.

In some areas, especially in the railway, water transportation and timber industries, progress toward collective bargaining in a spirit of goodwill and confidence is being made. Certain legal provisions may encourage its extension to other sectors. These include modification of the Trade Union Act to provide that appropriate unions be recognized by managements as bargaining agents for workers, that real collective bargaining take place before arbitration by Government is resorted to, and that agreements once reached through collective bargaining are honored by all parties to them. Ultimately, however, law can only point the way, and good labor relations and their counterpart, efficient production, are dependent on understanding and cooperative attitudes on the side of, and especially by the leadership of, both labor and management.

This is especially true in connection with the special problem of grievances, day-to-day complaints in connection with the conduct and conditions of work. Workers have an unquestioned right to make known their displeasures and to expect prompt consideration of them. However, grievances must not become, as they frequently do now, agents of continual disruption of the work process. The long history of collective bargaining in other countries shows that it is essential to set up a permanent "grievance machinery" for prompt processing of these small complaints jointly by representatives of both workers and management. That history also shows, with equal force, that the machinery must be manned by men of restraint and goodwill.

5. THE ATMOSPHERE OF WORK

It is perfectly possible that collective bargaining may be practiced sincerely and intelligently; that wages, hours, physical conditions of work, pensions, vacations and other work arrangements may all be highly satisfactory; and yet that the general attitude of workers in a large modern enterprise toward their jobs is one of dissatisfaction and discontent, inimical to their own happiness and to the efficiency of their work. Such a situation reflects the problem of psychological adjustment to a new technology. The transformation from peasant cultivation or handicraft production to modern industrial production involves a transformation of work from an act of independent creativeness, performed largely under self-determined conditions, to operations, many of them routine, guided by a common discipline. This radical change in the nature of work requires a changed set of attitudes as well as aptitudes. Unless these attitudes are acquired, labor under the new conditions loses its meaning, and anti-social work practices arise canceling the potential productive advantages of the new technology. Machines are poorly tended and run idle; pieces are spoiled; maintenance suffers. A modern factory, which at 95% efficiency would turn out needed products cheaply and help raise the living standards of the people, at 60% efficiency turns out goods at greater cost than the "inferior" hand process and is a burden to the economy.

The end result runs deeper than reduced living standards. When the worker derives no satisfaction from his work, minor frictions between him and his supervisors give rise to suspicion and distrust of management, and swell into a lingering bitterness, a bitterness containing the seeds of social revolt. The employer, even if the employer is the State, becomes an enemy, not a leader.

Higher wages and other benefits are not alone sufficient for solving this problem. The worker whose work itself is not satisfying will not feel contented, and will not apply himself merely because he is well paid and can perform what he conceives of as his drudgery under good conditions. A congenial atmosphere must be created which will elicit a new set of attitudes conducive to effective work in modern industry. The development of these attitudes is a problem in human engineering which must be solved specifically in terms of the prevailing habits and values in the Burmese culture. Its successful solution will depend primarily upon the imagination, resourcefulness, and dedication of managers of individual enterprises, trade union leaders, and government officials responsible for labor policy. However, general avenues of approaches for improving human relations in industry are the same in Burma as elsewhere. These can be summarized under three major headings.

Firstly, if his work is to be satisfying the worker must feel that the project of which he is a part is serving a worthwhile end. Workers in new Burmese industries will be taking part in the advance to a better Burma. That they are doing so must be dramatized to them in various ways. This can be done at the State Spinning and Weaving Factory, for example. It is the first factory of the new Burma, and its tasks, such as providing cheap yarn to the many handloom weavers, are important ones affecting the welfare of many people. By driving this fact home to workers, a sense of responsibility and importance can be created.

Secondly, the worker must be aware, as he does his individual job, of its importance in relation to the whole. The worker in every department must be given a simple understanding of the role of his department and of his individual work. For example, placards describing in simple language the relationship of the department or machine to the final product, its weekly achievement, and similar informational devices will stimulate morale. Human beings do not devote themselves enthusiastically to meaningless tasks. They can become enthusiastic participants in a meaningful one.

Thirdly, it is necessary to make every worker feel that he is individually valued as a person, not merely as the slave of a machine. While some of the techniques mentioned elsewhere can be fruitful in this direction, ultimately this is a matter of "personal," not "personnel" relations. The personal attitudes of supervisory personnel should reflect a regard of the worker as a person of integrity and dignity in his own right.

It is not sufficient that persons responsible for labor relations simply understand that each individual worker is an important individual, that his work is important in the whole project, that the entire project is a worthwhile part of raising the nation's level of living. These facts are not self-evident to workers and must be impressed upon them forcefully. Orientation discussions with new workers; small illustrated pamphlets; family visiting days, on each of which a well-organized effort is made to bring the families of the workers in one department to the plant, and to tell them of the achievements of the plant and of the department; contact with groups of workers by the managerial staff; athletic leagues among employees, these and numerous other devices can be used to give the worker a feeling of participation in an act of creation and of companionship in a group, which he gains in simple and direct ways in agriculture and handicraft work.

The attitudes and measures suggested involve no relaxation in discipline and efficiency. On the contrary the discipline necessary for efficient production is the more readily obtained if a worker is proud of his job and gains satisfaction from it. He must be made to realize that the job to be done is challenging, not easy.

As one employer who had learned the lesson of human relations stated, "You can buy a man's time, you can buy a man's physical presence at a given place, you can even buy a measured number of skilled muscular motions per hour or day, but you cannot buy enthusiasm; you cannot buy initiative; you cannot buy loyalty . . . You have to earn those things." Understanding how to earn them is one of the most challenging problems facing the economic leaders of Burma.

D. THE NEED FOR ABLE MANAGEMENT—A SPECIAL PROBLEM

1. THE SPECIAL IMPORTANCE OF MANAGEMENT

Although the remarks made in an earlier section with regard to providing other types of specialized manpower for the development program are entirely pertinent to managerial personnel, the problem of management in the development program has both special complexity and special importance which warrant its separate treatment. Since the problem of obtaining effective management is in part a problem of establishing the proper administrative organization it is also commented on in Chapter VI.

Management is that factor in the productive process which organizes, coordinates, and directs the three other basic factors in production—natural resources, labor and capital. Able management will make decisions which result in the optimum utilization of these basic factors of production, thus providing maximum benefits for society at the least possible cost. Poor and inefficient management will wastefully employ these productive resources, with the result that less goods and services will be produced and produced at higher costs. These considerations have special significance in the modern enterprise, whether public or private, both because the problems requiring solution are far more complex than is the case where smaller and less mechanized enterprises are concerned, and because the cost of inefficiency or failure in the larger or more modern enterprise is vastly greater.

The importance of managers in the Burmese economy is centered in three main areas. As the Government plays an increasingly important role in the development of the Burmese economy, and strives to achieve this development in major degree through development corporations in the industrial, mining and other fields, successful management within the development corporations becomes a critical factor. As autonomous or semi-autonomous corporations or boards are constituted to establish and operate new industrial, mining and other projects, competent management again plays a major role. Finally, since the successful accomplishment of the development program requires continual growth and increased efficiency in the private sector of the economy, the problem of management must be solved in this sector as well.

2. THE NATURE OF MANAGEMENT

It is a common mistake to think of management in the narrow sense of being concerned primarily with the production of goods within a plant. The compass of management is much broader. It embraces a broad area of decision-making responsibility which requires estimates of the market, domestic and international, present and future; judgements as to quality and pricing of goods which will stimulate sales; decisions as to merits of alternative raw materials and raw material sources; choices between various types of production equipment and production methods; decisions concerning working capital and credit requirements, sales and distribution methods, dividend policy, capital accumulation and re-investment; the conduct of management-labor relations; and a host of other responsibilities and judgements of which these are but illustrative and typical.

In mature industrial economies, the executive in charge of operating the enterprise is aided in the discharge of these duties by a staff of highly competent specialists. Generally speaking, this management team submits for approval and action by the board of directors its recommendation as to broad policies for conduct of the enterprise and is responsible for the execution of approved policies. The problem of management in Burma is particularly acute because Burma lacks, as of now, not only able operational management but also personnel qualified by their experience and ability to serve on boards of directors, and who could bolster operating management by formulating broad policies within which operational management personnel could function satisfactorily. This means that an especially large burden of responsibility must be shouldered by those placed in executive control of enterprises.

In this connection it may be observed that the experience of colonial Burma with respect to management could easily be misleading. In colonial Burma large-scale mining and trading enterprises were managed by resident staff who were primarily operational in character. Policy management, while invisible, was provided by the home office and by directorates of these corporations. In contrast to these arrangements, management in Burma will now be required to assume much broader responsibilities.

Before proceeding to an examination of the ways in which a solution of the managerial problem in Burma may be found, it will be useful to study briefly the experience of other countries in their attempts to solve problems similar to those confronted here.

3. SELECTED EXPERIENCE IN OTHER COUNTRIES

In recent years the Philippines, Ceylon, and Turkey have been among the countries which have sought through economic development schemes and projects to develop their economies more fully and raise the living standards of their people. In this process they have encountered problems of management analagous to those presently faced by Burma. In each case an analysis of the experience of those countries has been made by a highly competent and objective group. Pertinent selections from the reports made by these authorities are listed below.

a. Management: Philippines

The program of the Philippine Government sets a broad framework from which to formulate further plans and to select individual projects after thorough and complete engineering and economic study. It contains no provisions for measures to increase production from existing facilities. The magnitude of the program that should be undertaken at this time is limited by a variety of factors. It is not only a question of finance, but more important is the rate at which engineering, planning and construction can proceed, the availability of raw materials, and the need for power and fuel which must be met. Of special importance is the need for engineering and management personnel to assure the planning, scheduling and efficient operation of the investment that is undertaken.

The available technical and management skills in the

Philippines will not be sufficient for extensive development of industry for some time. That does not mean that industrial development must be postponed. It does indicate that rapid progress must be made in the training of engineers and business managers. This deficiency must be overcome by providing engineering education and by providing experience in actual operation. In the meantime, use should be made of competent and experienced planning, managing and technical personnel from abroad.

It is clear that the Government will have to take an active part in stimulating economic development in the Philippines. It will have to provide much of the planning and some of the construction for major enterprises. It will have to give financial assistance to stimulate private investment in the industrial fields of special importance to the economy. Precisely because of the large part that will have to be undertaken by the Government, it is important that its functions in this field be clear, and that it be prepared to perform these functions with honesty and efficiency.

The Philippine Government has for many years been operating various agricultural and industrial enterprises through government corporations. The National Development Company was originally organized in 1919. Existing government corporations were reorganized and certain new ones created between 1938 and 1941. In the postwar period, new corporations were organized for a multitude of purposes. The common experience was that a corporation once started, grew and took on new functions.

There are now 24 government corporations, not including subsidiary enterprises. They have come a long way from their original objective of creating industries to stimulate domestic production for export and for home needs. Their management has become cumbersome and burdensome. The directors of the government corporations commonly include cabinet officers, many of whom serve on a number of government boards, for which special remuneration is given. This involves more or less haphazard direction, so that the efficiency of the corporations and the government service is adversely affected. By the most generous evaluation, the larger number of the government corporations are inefficient, wastefully operated, and in some instances they have been misused.

Before the Government undertakes the responsibilities of the development program it should clean house in the existing corporations. What is of primary concern is that the development in the Philippines should be well and economically managed . . .

The extensive report of the Committee on Reorganization of Government Corporations submitted to the President of the Philippines on August 18, 1950, recognizes the defects in the operation of the government-controlled corporations and proposes to bring down their number to 16. It recommends that in the development of Philippine resources preference should be given to private industry (if necessary, with Government financing in the form of preference shares), and that the Government withdraw from trading activities in export products, from agriculture, and from other activities that are now in competition with private industry. The report proposes the abolition of PRATRA—a recommendation that the Mission strongly endorses. If the recommendations of the Philippine Government Committee on Reorganization are promptly implemented, a good start will be made toward more efficient development of the Philippine economy.

All government corporations should be placed under consolidated full-time management, free from any other obligation than to manage these corporations in the public interest. This could be done by establishing a Philippine Development Corporation as the responsible holding company for all government corporations. Its common stock would be wholly owned by the Government and would be issued in exchange for the Government's equity in the various organizations. Whenever necessary, the Government would also subscribe to additional shares to provide capital for the operations of the corporation. The directors of the Philippine Development Corporation would be government appointees, barred from holding any other government or private position.

Report to the President of the United States by the Economic Survey Mission to the Philippines, Washington, D.C., October 9, 1950, *pp.* 66–68.

b. Management: Ceylon

Lacking a broad industrial background which is only now being built, it is only natural that for the moment Ceylon has few persons of general industrial management experience.

Among private plants, distinction between the functions of ownership and management is less frequent in Ceylonese-owned enterprises than in the others. As larger units are built, however, it is becoming clearer to the investors that ownership does not automatically confer management ability, In some cases trained foreign managers are being hired, at least until local personnel can gain experience. This is more common in technical positions, for Ceylonization pressure has made it extremely difficult to import skilled administrative personnel.

Where management and ownership are distinct, it is noted that maintenance and replacement of capital equipment are often better. But as a rule Ceylonese factory owners tend to take out large profits at the expense of maintenance, reinvesting these (if at all) in other ventures or in land. Efficiency then suffers through deterioration, and so does the psychological incentive for good performance.

Reports from different factories show a wide variation in the output of workers, even with the same equipment. Similar variations are noted in the history of individual plants. All evidence indicates that such differences are largely attributable to the choice of managers and supervisors, their qualities of administration, initiative and leadership, and their understanding of the worker as a fellow individual.

Ceylon's cement plant, located atop the Kankesanturai limestone deposits on the Jaffna peninsula, has been the first of the Government's modern factory projects to go into operation. Started in August, 1950, the plant uses the dry process and a single kiln equipped with a pre-heater. Its rated capacity is supposedly about 300 long tons per 24-hour day.

Although frequent press references give the present output at 250 tons per day, the records of the factory indicate that on very few days has the production exceeded 225 tons. These records also show that from January to October, 1951, the plant was shut down for a total of some 50 days, in periods ranging from a day to several weeks, because of various troubles. Hence an actual output approaching rated capacity is still far from being achieved. Reasons for this are, in the main, inherent in the administrative structure. At the time of the Mission's visit new orders were arriving at the rate of 700 to 800 tons daily. Outstanding orders in mid-November totaled 7,000 tons, and buyers were asked to limit new individual orders to 26 tons each—representing two railroad carloads. Meanwhile, not only was the effective plant capacity limited to a third of the demand, but the shortage of railroad cars prevented movement of more than 60–70% of the output. Thus, until the transport difficulty is removed, installation of a second kiln will not solve the problem.

Mechanically, the plant is a fairly good one. Initially a poorly constructed roof collapsed; since then the preheating system has given some trouble; the limestone crane is overworked through unnecessarily repetitious handling of material; and the sacking and carloading operations could be improved to reduce losses through breakage of bags. But these defects will soon be corrected.

Most of the shutdowns and troubles can be attributed, directly or indirectly, to the difficulties of outright government operation of the plant, and are so recognized. Replacement parts have been slow in arriving because of lengthy government purchase methods; and constant official intervention in management has made it difficult for the plant to retain competent technical help for more than short periods. As for operating costs, it appears that the factory employs from two to three times the number of workers that it needs.

The Mission believes that removal of the management functions from government offices will alleviate at least 90% of the cement plant's troubles, and will permit it to make a real contribution to the island's development as a soundly based industry. The management problem in government-owned industries is a very acute one. It is now acknowledged by all that their present administrative structure is hopelessly unsatisfactory.

To their credit, it must be said that officials have been quick to recognize the need for experienced industrial managers and have imported them. But these managers are unable to give their best performance while virtually all administrative authority is retained by the Ministry. Inevitably, the very decisions for which their skill and judgement were sought are made for them by government officials instead. Hiring, firing, production planning, accounting, purchasing, distribution and sale are all handled through the inherently cumbersome mechanisms of government, and a resulting large overhead is charged against production cost.

Some very competent managers have been obtained; but delays, veto and frustration have caused a number to resign. This, and the fact that governmental salary limitations have not kept pace with the industrial world, now makes it difficult to replace them with the best men.

A solution probably lies in conversion of these enterprises to ordinary corporations where responsibility for efficient management can be left to competent managers chosen by a board of directors, and where the Government can limit itself primarily to the role of stockholder and recipient of dividends.

Some progress is being made in discussions toward this goal. However, it is felt that current local thinking has not yet fully evaluated the real essentials of the problem. One proposal, disclosed in a memorandum released to the press in February, 1952, would create government-owned corporations but would actually leave all final operating authority in the hands of the Ministry of Industries, where it is now. We fear that this would merely continue the present system under a new name, and would solve nothing. Further consideration will show that the key to good management and protection of investment is to delegate authority to competent personnel with a minimum of restriction, and to hold them responsible for performance.

"The Economic Development of Ceylon," report of a mission organized by the International Bank for Reconstruction and Development at the request of the Government of Ceylon the Johns Hopkins Press, 1953, *pp.* 519–520 *and* 535–537.

c. Management: Turkey

The State's enterprises are bureaucratic and top-heavy. Authority is heavily concentrated at the top and is not sufficiently delegated to lesser officials and employees. We referred in Chapter VII to these characteristics in the transport agencies. They are equally typical of the industrial enterprises. Channels of communication are unnecessarily complicated and routine activities are hampered by restrictions and paper work to such an extent that productive efficiency is seriously impaired. Factory employees, as far down as minor clerical staff, are hired and dismissed by the central office of the holding company, not by the factory management. The Sumerbank's head office also intervenes in the purchase of raw materials and supplies as well as in the marketing of products of individual factories. As a result, plant managers can exercise little initiative and tend merely to carry out orders from above. Top Sumerbank management, on the other hand, is hampered by lack of information on operations and overburdened with paper work. In the accounting systems of public enterprises, terminology is not uniform, so that financial statements can rarely be read and interpreted correctly without consulting the responsible accounting department. Heavy administrative charges add to costs of production and unnecessarily raise the prices of finished goods.

Operation of public enterprises has in general been hampered by the fact that they do not have sufficient independence to operate as business entities. A substantial amount of authority should be delegated to managers of individual undertakings. This would increase their efficiency as well as give wider experience to the managers. Only through such a delegation of responsibility can good managers be developed and incompetent ones weeded out.

The managers of individual enterprises should have the authority to operate on the basis of a business budget as approved by the responsible minister. This means that each plant or agency should pay its current operating expenses out of current revenues. Other powers which should be delegated to individual factory managements are freedom to buy raw materials, to hire or dismiss personnel, to set wage rates on the basis of local labor market conditions and to market their goods and services under general price policies approved by the responsible minister.

Based on information received from official Turkish sources.

4. LESSONS FROM THE EXPERIENCE OF OTHER COUNTRIES

Among the points which emerge clearly from the experience of these countries, and which seem pertinent to comparable problems in Burma, are the following.

(a) Deficiencies in indigenous management and technical skills do not mean that industrial development should be postponed, but indicate rather that for the short run, use should be made of competent personnel from abroad, while indigenous personnel are simultaneously trained.

(b) Participation on boards of directors by government personnel on a part-time basis tends toward haphazard direction, and adversely affects the efficiency of the corporations concerned as well as the government service. This applies to the directors of government development corporations in particular.

(c) All government corporations should be placed under broadly empowered, full-time management which is free from any obligation other than to manage these corporations in the public interest. Managers are unable to give their best performance while virtually all administrative authority is retained by the ministry concerned. Such administrative interference makes it difficult to retain competent managers once they have been engaged. The key to good management and the protection of investment is to delegate authority to capable personnel with a minimum of restriction, and to hold them responsible for performance.

(d) An important function of the government development corporation should be to provide trained personnel who would be available for all government enterprises.

(e) Another important service of the development corporations should be the provision of engineering, industrial research, and other advisory services to small and medium-sized industrial enterprises, both public and private. Foreign advisers and technicians should be employed for this purpose as required. One of the most important functions of such personnel should be the training of indigenous personnel.

(f) To the maximum possible extent, the Government should attempt to foster and encourage economic development by private enterprise so as to minimize as far as possible its own responsibility for management.

(g) Preferences granted by Government to government enterprises conceal inefficiency and prevent the weeding out of incompetent managers.

E. POSSIBLE SOLUTIONS TO THE MANAGEMENT PROBLEM

1. DELEGATION OF AUTHORITY

There is no easy solution, no single solution, and no basic short-range solution to the problem of providing competent management. Short-range expedients, however, can be found. The most certain principle which can be laid down is that action should be guided by the lessons of recent experience elsewhere to avoid making in Burma the mistakes which other nations have made, even if this involves, as it must, abrupt departures from established ways of doing things. Perhaps the most important of the lessons which this experience has provided is that adequate authority must be granted to personnel charged with managerial responsibilities.

Even an individual who possesses managerial talents, training and experience in a high degree will not be able to administer a venture effectively unless he is adequately empowered to exercise this function. This does not imply that *carte blanche* should be given to the manager. The board of directors must be responsible for the basic policies. At the same time, however, they must delegate to the general manager full authority to make the operational decisions necessary to execute these policies. The manager must, for example, have authority, under general policies laid down by the board of directors, to employ, discharge and promote personnel; to purchase material and equipment; to supervise production; and to make sales decisions. All important decisions in these fields must of course be subject to review after the fact by the directors for compliance with the overall policy, but to require approval for each separate decision before action can be taken paralyzes the decision-making function and inevitably destroys efficiency. Delegating adequate authority to the manager, and holding him responsible for results under the authority granted him are the pillars of effective administrative organization.

The danger that these practices will not be followed is the greater because of the fact that managing boards without industrial experience as in Burma may not understand the importance of the delegation of responsibilities referred to above, and may therefore insist upon a degree of control of operating details which will make successful administration impossible.

Similar administrative arrangements should exist between any two related levels of responsibility. Individual project boards must be adequately empowered by the Development Corporation, and these in turn should be subject only to the requirement that they conform with broad government policies. To delegate authority which has customarily been retained in the past is a difficult thing, as difficult, perhaps, as it is for a mother to part from her child. But excessive mothering will prevent the normal development toward maturity of the child, if indeed it does not smother the child to death. In the same way, if Government embraces the budding development and project corporations too closely, they will be unable to achieve maturity and responsibility.

With the need for delegation of authority firmly established, the Government can turn its full attention to the provision of competent personnel to exercise this authority.

2. PRIORITIES IN ATTACKING THE PROBLEM OF MANAGEMENT

Attempts to solve the problem of management must focus initially on the public sector. While, as has been pointed out, the problem is important in the private sector as well, the advances made in the public sector will permeate in time throughout the economy. Further, the Industrial Development Corporation can make a significant contribution to the improvement of the quality and operation of management in the private sector of the economy by making available the results of its research activities, by the advice and assistance of its technical staff, and by the policy guidance which can be given by its loan and investment personnel.

Within the public sector, the level at which the management problem must first be solved is at the level of the major development corporations themselves, in industry, mining, agriculture, and in other fields in which they may be constituted. The development corporations are the key to successful development in these broad areas of economic activity. Unless they are properly organized, staffed, and ably and dynamically conducted, the development program will have little chance for success. The chief problem at this level is to assure selection of the most able persons available for the executive staff and for membership on the board of directors, and to promote effective operation by appropriate grant of authority to the board, including adequate working capital; by the necessary delegation of authority as well as responsibility by the board of directors to the chief executive officer of the corporation; and by attaching to the board and the chief executive officer technical advisers of outstanding competence in the various fields in which technical assistance is required. For the short run at least, it will be necessary to engage a large number of foreign technicians for this latter purpose.

So far as the project corporations which will be set up by the development corporation are concerned, the chief problem is that of supplying able operational management. Because it will be difficult to find people of the necessary experience and ability, who are not already overburdened with other tasks, to serve on the boards of directors of these corporations, the operational management of these corporations will need also the experience and ability to formulate and recommend broad policies covering the entire range of operations of the enterprise.

Short-run solutions to these high-priority management problems require a consideration of the qualifications which must be possessed by competent managers; of the availability of such personnel within Burma; and of the arrangement which may be made to procure foreign managerial talent. For the longer run, consideration is required of the ways in which Burma can develop able managers of her own.

3. SPECIAL QUALIFICATIONS FOR EFFECTIVE MANAGERS

The technical knowledge and the business judgement which is required for efficient administration cannot be obtained merely by academic training, no matter how comprehensive and advanced. A high degree of native talent is essential and even if this is possessed, considerable experience is needed to apply academic knowledge to practical operations, before reliable judgement can be expected. To give an engineer or other technician responsibility for important operating decisions before he has had some years of experience in subordinate positions and demonstrated his ability in them is to run a grave risk of administrative failure.

Knowledge of personnel management is as essential to administrative success as is technical knowledge. The manager must understand how to treat labor fairly, how to stimulate labor's interest in the work and how to make labor eager for the success of the enterprise. The importance of this aspect of effective production, which is inherent in industrialization itself, was stressed earlier. Establishing the personnel relationships which are necessary to create favorable work attitudes requires personal qualities and talents on the part of managers which are possessed by relatively few persons, and requires in addition a special knowledge of industrial psychology and of techniques for successful handling of labor union relations and workers' grievances. Neither the special personal ability nor the knowledge of personnel-relations methods is acquired solely by training; both depend in part on experience.

A third personal characteristic which is important for efficient management is coordinating ability, the ability to keep in mind many details and relationships and to organize the necessary administrative procedures and records for keeping production flowing smoothly and at a maximum pace. Such judgement, foresight, and organization ability are in part inherited. But even the most skillful manager will not possess them before he has had experience in a venture similar in nature, though not necessarily identical, to that which is placed in his charge.

4. LACK OF QUALIFIED MANAGERS IN BURMA

It is an unfortunate fact that very few Burmese nationals now possess the necessary combination of talent, training and experience to assume management responsibility for sizable industrial ventures. This is an inevitable consequence of the economic history of Burma. When the British occupied Burma and introduced some industries, the Burmese were untrained and inexperienced in modern productive methods, and disinclined by their culture and by their independence of spirit to enter upon them. There was, furthermore, a language barrier. On the other hand, there were considerable numbers of Indian and Chinese nationals with varying degrees of industrial experience and training and with whom the British had had previous economic contact. These were probably the major reasons why administrative and managerial posts which were not occupied by Europeans came to be filled by non-Burmans.

These statements are true of every major industry. The large rice mills were owned and operated by foreigners. Teak extraction and milling was largely in the hands of Europeans, and there were no Burmans in high administrative positions in the industry. Neither the Burma Corporation nor the Mawchi Mines placed Burmans in the more responsible positions. The Burmah Oil Company was administered by Europeans. No Burmans had managerial responsibility in any large bank, and few, if any, in any large import or export business.

These conditions persisted. It was the course of least resistance to continue to employ personnel with the greatest industrial and commercial training and experience for key administrative posts. As a result very few Burmese at present have acquired the necessary training for industrial management, and even fewer have experience in upper-level administrative positions.

Because experienced managers are essential in initiating new ventures, it will be necessary in most cases to employ non-Burmans for the present. But to prevent the perpetuation of this situation, vigorous measures must be taken to accelerate the training of Burmans in technical and managerial skills, and to give them the necessary experience.

5. OBTAINING FOREIGN MANAGERIAL AID FOR NEW ENTERPRISES

Effective management is a demanding task. It requires continuous vigilance, and exacts at times a heavy toll in nervous tension. The inducement to the continuous exertion of nervous energy must be great. That inducement is provided only in part by financial rewards and by the satisfaction of creative achievement. To a manager operating in his own country, inducement is also provided by the esteem which he achieves and the positions of higher rank to which success may lead. But to a man operating for a limited term in a foreign land, that inducement is less powerful. The arrangements under which foreign managerial aid is obtained are therefore of the first importance.

A wide variety of such arrangements is possible.

(a) A Burmese national may be designated as manager, under government ownership, and foreign technicians may be employed to advise him.

(b) A general manager and the necessary technicians may be employed from abroad, on an individual contract basis.

(c) A joint venture may be entered into between the Government and a foreign firm experienced in the industry, either on a fifty-fifty basis, or with one party holding predominant ownership, but in either case with the foreign firm supplying the management personnel.

(d) Management may be provided by an experienced foreign firm operating under a management contract, with a profit-sharing or similar provision as an inducement to efficiency.

(e) A management contract may be let to an experienced foreign firm on a straight fee rather than a profit-sharing basis.

(f) A foreign firm might supply the equity capital in such a venture with the Government providing loan capital but not participating in ownership.

(g) The entire venture might be financed by foreign capital operating under certain guarantees extended by the Government as to raw materials, markets, security of capital and returns, etc.

(h) Ownership of the enterprise might be domestic in character, assisted by Government loans and with management assistance provided by foreign technicians.

Undoubtedly some of the eight possibilities outlined above are more promising than others. An elaborate analysis could be made of the relative advantages and disadvantages of each. Before attempting even a brief analysis, however, it should be emphasized that these alternative arrangements cannot be adequately evaluated in the abstract. Flexibility must be retained, and the choice of arrangements must be conditioned by the practical possibilities existing in the case of each venture for which management must be found. The person or firm available to supply the needed management will be in the long run just as important, or perhaps even more important, than the type of arrangement selected for engaging that person or firm. For example, it is quite clear that the employment of a foreign firm on a fee basis is not likely to be as satisfactory as a management contract in which provision is made for profit-sharing, or bonuses, to provide real incentive to the management firm. On the other hand it is perfectly possible that management firm "X" will perform more satisfactorily on a fee arrangement than would management firm "Y" operating on a profit-sharing basis. With this word of caution as to the importance of flexibility in the selection of arrangements, a brief discussion of the relative merits of these various possibilities for foreign managerial aid is offered below.

(a) The designation of a Burmese national as manager of an enterprise with foreign technicians to advise him might work out quite well, provided that the venture is not a very large one, provided that the manager has had some experience in a related field, and provided that the range of problems that would be encountered would be largely technical and on the production side. The greater the degree to which these conditions are departed from, the more weighty are the reasons for selecting some arrangement which will place more experienced management in charge.

The selection of the individual is extremely important. Administrative talent is rare. The assumption that a man can manage a plant effectively because he has the necessary technical knowledge is false and dangerous.

(b) The employment of a general manager and other technicians from abroad under individual contracts involves serious hazards. The chances of finding the right kind of individuals are problematic, particularly where the manager is concerned. The broad range of talent, training, experience and policy-making ability necessary is everywhere in short supply and the probabilities of finding persons of this caliber by individual recruitment seem rather remote. The person must be one who not only has been technically and administratively successful in his industrial field, but also one who understands problems of personnel management in relation to workers of a different race who have no industrial experience, and who understands the problems of governmental relationship which will be involved. The experience at the government Cotton Spinning and Weaving Factory is an evidence of the possible weaknesses which attend this approach.

(c) A joint venture may be entered into with a foreign firm experienced in the industry. Under such a venture the foreign firm would share in the capital investment, and would share correspondingly in the profits. The joint venture with the former Burma Corporation seems to be working well, and is an illustration of the possible success of this form of organization. Other joint ventures for the operation of existing enterprises are now being negotiated.

Arranging joint participation in a new industrial venture, on terms which will attract the necessary foreign capital and at the same time be equitable to the Government and the people of Burma, is a more difficult undertaking than is arranging a joint venture with an enterprise long established in Burma.

In establishing a joint venture, mutually acceptable provisions are far from enough. Some operating policies may cause frictions. Provisions concerning them must be clearly spelled out in the contract. For example, principles on which prices and wages are to be determined must be clearly indicated, to avoid later dispute caused by the Government's desire for low prices or high wages, while the foreign company may wish to maximize profits by contrary policies.

Over-all control of a joint venture will of course be by a board of directors on which the Government and the foreign company are represented. Equal representation on the board is probably the most advantageous arrangement. Domination of policies by either the Government or the foreign company will hardly be successful. Unless the conditions of the joint venture are so clearly and fairly spelled out in the contract that reasonable men can subsequently agree upon policies without deadlock, chances of success of the venture will be small.

One of the aims of the management of the venture must be the training of Burmese nationals as rapidly as possible to take over the administrative positions. Preparing them to do so will be an important part of the function of the foreign managerial and technical staff. One of the most important sections of the contract will be that dealing with this matter, for it will not be easy to arrange provisions which stimulate the foreign company to most efficient management at the same time that it is working vigorously to create conditions in which its participation will no longer be necessary. Yet it is entirely feasible to establish such provisions. A minimum period of years within which the foreign company is guaranteed against compulsory sale of its interest to the Government is a requisite.

Joint ventures may be entered into with the Government taking either more or less than a half share. At first glance, an arrangement of this type would seem to obviate some of the difficulties or complexities which attend the joint venture on a fifty-fifty basis, because the partner undertaking more than a 50% share would have the major voice in the making of basic policy decisions. In practice, however, such an arrangement might be exceedingly difficult to design. In cases where the Government held a minor share, it still could hardly afford to permit its partner to operate out of harmony with the Government's views, a fact that would be well known to a prospective partner. On the other hand, the private partner would probably be reluctant to enter into a relationship where he would hold a minor share and therefore have little or no voice in the making of critical decisions. The probability of such arrangements therefore may be considered remote.

(d) The fourth possibility is complete ownership of the venture by the Government, with development and management provided by an experienced foreign firm under a management contract which contains profit-sharing or similar provisions. These provisions may simply take the form of a share in the profits over a specified period of years without any capital investment by the foreign firm. Alternatively, the firm may be given an option to purchase stock at a specified price, so that it will have an inducement to create profits which will make such a purchase advantageous. In general, the comments above concerning the conditions and provisions necessary for the success of a joint venture apply, though in somewhat lesser degree, to such a management contract.

(e) The fifth possible arrangement is complete ownership by the Government, with initial management of the venture provided for by a management contract with a foreign company on a straight fee, rather than profit-sharing or other basis. Such a contract will provide for management by the foreign concern for a period of say three to ten years, depending on the nature of the venture. The company would agree to provide competent staff and professional judgement for construction of the plant, initiation and conduct of operations, and training of Burmese nationals at all levels of production and administration. It is entirely possible to obtain the services of a company to do this effectively without a profit inducement. But for such an arrangement to be effective, the company employed must be one which depends for its reputation and success upon the efficient conduct of such management operations, either because it is primarily a management company or because in some other way the success of such operations is interwoven with its business standing. If these conditions do not exist, the inducement to efficient operation provided by a fixed fee only can scarcely be compared to that provided by a share in profits.

(f) Ventures might be organized with foreign equity capital, i.e., capital representing ownership, with Government providing loan capital, especially if government long-term loan assistance comprised a large share of the total capital required. Such an arrangement would absolve the Government from any responsibility with respect to management other than the safeguards usually exercised by lenders to protect their capital. It seems quite likely that foreign firms might be interested in undertaking ventures in Burma on such a basis, particularly if the prospect of earning substantial returns on a modest capital investment seemed bright and if convertibility of the earnings to other currencies could be assured. Such an arrangement, however, could yield to the foreign owners a return quite disproportionate to the investment made, and would scarcely be in harmony with the economic views of the Government.

(g) Ventures could be financed entirely by foreign capital, with the Government providing the necessary guarantees concerning convertibility and freedom from nationalization. The possibilities of such arrangements do not seem very great. The profit-making opportunities which exist in advanced economies where such capital is available are so large these days that investment abroad in an under-developed country like Burma would not seem very attractive unless the prospective profits were very great. By the same token, however, the Government would hardly wish to encourage investment of this kind if the profits to be made by such concerns would be so large as to be embarrassing.

(h) Domestic ownership and management of enterprise, assisted by government loans and by foreign technicians, might be quite feasible where Burmans have had some experience in the particular industry or in a related field, where the size of the venture is not very great, and where no especially difficult or unique problems are likely to be encountered. Such an arrangement should be considered in the case of contemplated ventures in fields where a domestic private industry already exists, and where there already exists some nucleus of capital investment and managerial know-how.

It would appear then, from the point of view of the possible arrangements themselves, that the most likely methods of providing initially the management necessary for proposed industrial ventures are methods (a), (c), (d), and (h). While it is recommended that in each case thorough consideration and weight should be given to the persons and firms likely to be involved in an arrangement, as well as to the type of arrangement itself, it would seem that, for the short run and for the more important ventures in which the Government is interested, the management contract with an experienced firm containing an incentive feature such as profit-sharing is likely to be the most effective and satisfactory method for providing the management ability and experience necessary. It needs scarcely to be emphasized that an essential concomitant of any such arrangement must be provision for the training of Burmans in positions of responsibility so that they can in time assume the full burden of management themselves.

6. DEVELOPMENT OF INDIGENOUS MANAGEMENT IN THE LONG RUN

Concurrent with the short-run solutions which have been discussed above, steps must be taken to assure the preparation of Burmans in increasing numbers for responsible management positions. While the major steps in this process must be the placement of Burmans for on-the-job training with the foreign managements engaged, additional measures can and should be taken.

Promising young men should be encouraged by scholarships, stipends, and similar inducements to undertake studies which will prepare them for managerial positions. These studies should then be followed carefully by planned programs to give trainees on-the-job experience in the productive processes with which they are to deal as well as in administrative work. The training arrangements involve problems similar to those involved in the training of other professional personnel. These have been discussed in Section D above.

An organized program is also needed for providing assistance to Burmans presently engaged in businesses of their own. Such a program would include the availability of research, technical, and advisory services of the Industrial Development Corporation. It might also include the services of an office of small business development which could be set up in the Ministry of Industry. Such an office, working in close cooperation with the Industrial Development Corporation, could make a substantial contribution to the advancement of managerial know-how and ability in the private sector of the Burmese economy.

On a somewhat broader scale, every reasonable encouragement and aid should be given to the development of industry and commerce in the private sector of the economy. This is indeed the best training school for managers, where experience serves as teacher, and survival is the stern criterion of economic performance.

F. SUMMARY OF RECOMMENDATIONS

(1) University facilities for the training of professional workers must be greatly expanded. Intermediate colleges should be established, permitting the Rangoon facilities of the University to be used mainly for upper division work.

(2) The desire to increase the number of students in professional courses must not prevent improvement in quality. Financial assistance for students of promise should be combined with rigorous standards for all students.

(3) The present highly desirable program of advanced training abroad should be expanded; methods of selection of trainees should be improved.

(4) Employment of foreign professional personnel should be continued for some years.

(5) The Government Technical Institute at Insein should be expanded and given improved equipment at once. Salaries must be increased to attract sufficient staff.

(6) The Artisan Training Center at Rangoon should be expanded and centers opened promptly in other cities.

(7) The excellent work of the Rehabilitation Brigade should be encouraged. At least a large share of graduates should be released for public employment outside the Brigade or for private employment.

(8) The training of sub-professional and skilled workers, referred to in recommendations (5), (6), and (7), should be placed under the administration of the Ministry of Industry, or under an autonomous board.

(9) A center for Training Aids should be established to provide aid in in-service training throughout the Government.

(10) A comprehensive program for technical training should be prepared.

(11) Where applicable, bonuses for output above a norm or profit-sharing should be adopted as a work incentive. In general, straight wage increases should wait upon increases in productivity.

(12) Industrial safety devices should be required.

(13) Collective bargaining and the establishment of grievance machinery should be encouraged.

(14) An industrial revolution in Burma as in any country will create problems of worker attitudes which must be met by measures to make workers aware of the worthwhile ends the enterprises are serving, the importance of their individual parts in the production process, and the recognition granted to

their value as individuals and members of a cooperating group.

(15) The experience of other countries should be studied to avoid their errors in operating public enterprises.

(16) Key attention must be paid to obtaining efficient managers and to establishing conditions conducive to effective management.

(17) Management boards must delegate wide authority.

(18) In seeking managers, technical knowledge and successful experience, ability in personnel relations, and broad administrative and coordinating ability must all be sought.

(19) The success of any arrangement for management of a new enterprise depends in large degree upon the quality of the individual manager or firm involved. With this qualification, the most promising arrangements probably are as follows: For smaller and less complex enterprises, in which Burmese nationals have had some experience, employment by the Government of a Burmese national with foreign technical advisers as needed, or domestic private ownership and operation assisted by government loans may be most advantageous. For larger and more complex enterprises, a joint venture where feasible and where one is not a management contract with a foreign company, may be most effective.

(20) Any type of arrangement must make careful provision for the speedy training of Burmese personnel.

PART III

AGRICULTURE AND IRRIGATION

CHAPTER VIII

AGRICULTURE

A. OBJECTIVES

Agriculture is probably the most important factor of the Burmese economy for two primary reasons. First, it produces 38% of the national income, and is the greatest single source of foreign exchange. Second, agriculture employs approximately two thirds of the labor population and therefore supports the greater part of that population the raising of whose living standard is the objective of the development program. To the extent that increased foreign exchange will be required, and particularly in the early stages of the development program, agriculture must provide the major share of the increased output. Even though industrial development progresses rapidly, industry will remain a small sector of the economy for a long time. Increases in agricultural income must accrue to the farmer in order to increase the market for industrial products, and to the Government in order to support the capital investments required to expand industry and to mechanize productive operations of all kinds throughout the economy. Progress in agriculture must therefore be included with progress in other industries to prevent destructive unbalance between production, marketing and foreign exchange.

The agricultural development program shares with the general development program the basic objective of providing all the people of Burma with a greater share of the world's goods and opportunities for intellectual and cultural advancement through increased productivity of the individual and fuller and more efficient exploitation of physical resources. If, because of its key position, agriculture is relied upon as the principal initial resource of the federal development program to attain the established goal of increasing the per capita income by 1960 to 5% greater than its prewar value, agricultural output must be increased by 77% of its 1951–52 production. Its present production is only 81% of its prewar value. Of the required increase, 61% can be obtained by the restoration of prewar acreages and by the addition of new acreage, 11% from increased efficiency of production and 28% from state marketing.

B. PRESENT AGRICULTURAL DEVELOPMENT

1. BASIC AGRICULTURAL RESOURCES

a. Climate

The principal agricultural areas of Burma lie between the 16th and 24th parallels of latitude. The climate is characterized by high temperatures, varying approximately from 60° to 95° F. throughout the year, and heavy rainfall. The country is rather sharply divided by rainfall variations into Lower Burma with precipitation from 80–250 inches per year, the Dry Zone having 25–50 inches annually, and Upper Burma with rainfall approximating 100 inches annually. Each of these divisions occupies approximately one third of Burma, the central portion constituting the Dry Zone while the north and south extremes form the Wet Zones.

b. Soils

Soils of the agricultural areas consist principally of alluvium and deposits of the Peguan and Irrawaddian series. The Shan States are separated from the rest of Burma by a fault line extending the length of the country, and forming the boundary line of a large limestone plateau that stretches east into China. The principal agricultural soils are characteristically heavy-textured clay at subsoil depths, often overlain with lighter surface soils. The soil reaction is extremely acid in the Delta, gradually changing northward to a neutral or slightly alkaline reaction in the Dry Zone.

c. Topography

The topography of the country is characterized by north-south Yomas of uplifted, broken terrain that pass between wide, flat valleys. In lower Burma the topography is typically flat. The Shan States have a rolling topography with occasional wide valleys having moderate slopes.

The conditions of warm temperature throughout the year, ample rainfall, and flat land of relatively fertile soil are ideal for excellent agricultural production, and typical of the major rice production areas of Burma.

d. Human Resources

Compared to most countries in Asia Burma is fortunate in having land resources that are large in proportion to the population (see Plate 1). However, there are large areas of formerly cultivated land which remain idle as a result of insecurity, and there has been a 10% increase in population since 1941. The result is a surplus of agricultural labor in relation to currently cultivated crop area. As prewar acreage is restored this surplus labor force will be reduced but there will be ample labor for more intensive cultivation and for expansion of cultivated acreage.

The 1931 census indicated about two thirds of the labor force to be engaged in agriculture. About 27% of the labor force were classified as agricultural laborers, 15% as tenant cultivators and 25% as cultivating owners. Subsequent increase in the amount of tenancy and postwar reduction in the size of farms have probably reduced the relative number of cultivating owners and agricultural laborers and increased the number of tenant cultivators.

e. Standard of Living and Income

An agricultural laborer receives from 100 to 150 baskets of paddy plus board for working seven months. This amounts to about K40 to K50 per month if he is able to wait until harvest time to collect his wages. Actually he usually draws cash advances at the rate of K1·50 to K2 per basket for at least part of his wages so that his actual wage may be as low as K20 per month. His wife and other members of the family must also work, and during the remaining five months of the year the laborer must find other employment in rice mills, carting, petty trades, handicrafts or other unskilled work. Income from such pursuits run from about K0·50 to K3 per day. Wages in rural areas are usually paid in terms of paddy. The monetary wages are about two to three times the prewar level but the prices of cooking oil, longyis, and other items which must be purchased have risen much more.

The differences between the incomes of laborers, tenants and the average owner cultivators are not great. The income derived from agricultural operations is insufficient and subsidiary occupations help to make up the deficiency. Such work includes forest work, carting, boating, fishing, thatch making, weaving and processing of products. The cultivator is in a somewhat better position than the laborer but his income is still substantially below that in other sectors of the economy. This disparity is clearly indicated by the fact that agriculture with two thirds of the labor force receives only 38% of the national income.

2. LAND USE

a. Cultivated Areas

A breakdown of prewar land use in divisional Burma, covering a five-year period ending in June, 1940, appears in Table I–2 of Chapter I. The 170·4 million acres of total area are listed by districts according to use, with the exception of approximately 66·8 million acres lying principally in the Chin Hills, Shan States, Kayah State, Naga Hills and Myitkyina for which no record of use is available. The over-all breakdown shows approximately 12% of the total area in reserve forests, 24% suitable for agriculture, 25% not suitable for agriculture, and 39% unknown. The 40·4 million acres of land suitable for agriculture is further divided to show average annual use with net acres sown comprising 43% of the total, 9% left in fallow, and the remaining 48% not cultivated. The areas listed as potentially cultivable, and a portion of the 66·8 million acres with no use record, can be expected to provide ample room for future expansion of agriculture in the country. The map titled "Land Topographically Suited for Agriculture" (Plate 2) gives some indication of the extent of the potentially cultivable acreage in Upper Burma. Further areas of potential development occupy the Shan Plateau where the climate is favorable for such products as wheat, fruit and potatoes, and particularly for livestock production.

The most highly productive areas are those of the Delta and along the valleys of the Irrawaddy and Sittang Rivers. The Dry Zone is less productive, principally because of the lack of water. Upper Burma and the Shan Plateau are least productive because of their remoteness, their traditional pattern of hillside cultivation, and the topographic conditions of that part of the country.

Burma is unique among Asian countries in having a large acreage of cultivated or cultivable land per capita. It is estimated that approximately 2·2 acres of cultivable land are available per capita. Unusual too are the characteristics of much of the cultivable land in being essentially flat and receiving sufficient moisture for annual, single crop cultivation without irrigation.

b. Areas Abandoned because of Insurgency

Some of the cultivated acreage is under insurgent control. Approximately 2 million acres, or 10% of all formerly cultivated land, is now out of cultivation and degenerating into shrub and forest growth. These areas are not well defined, but occur generally in sections of the country not under government control. As these areas are made secure, they can be expected to return to cultivation rather quickly.

MINISTRY OF NATIONAL PLANNING

COMPARATIVE POPULATION DENSITY OF SELECTED COUNTRIES

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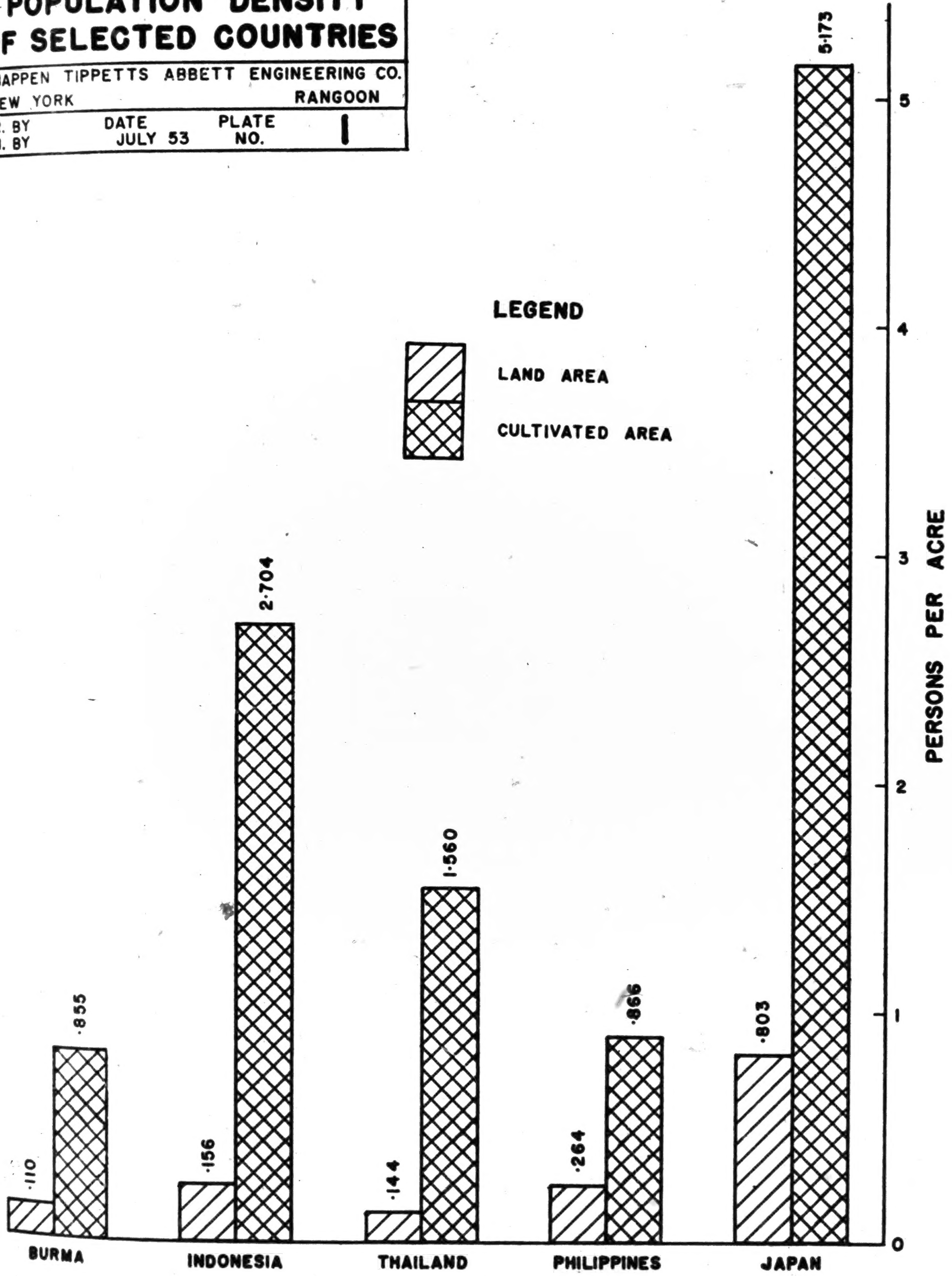


c. Crops

Agricultural production centers around rice. Two thirds of all cultivated acreage is devoted to that crop. The lack of a practicable alternative to rice production on heavy flat lands, and a monsoon rainfall, have encouraged the high proportion of rice. Serving the dual function of providing staple food in the country and supplying the major source of national income for Government, the predominant production of rice is unquestionably far better suited to requirements of the economy than any other combination of agricultural crops that could be grown under the present farming system. Growing conditions for rice are best in the Delta, and that area produces the export fraction of the rice crop. The favorable rice-producing area extends beyond the limits of the Delta proper, notably along the Irrawaddy and Sittang River valleys, but its adaptability to rice production declines northward. The demand for rice as the single staple food of the Burmese people results in its production in some areas not well suited to the growing requirements of the plant. The lack of good communications has, on several occasions, left upper Burma in a condition of serious rice shortage while rice glutted the market in the Delta.

After rice, the production of vegetable oils is most important as a result of the dietary demand for oil products within the country. Oleaginous production is practically restricted to the Dry Zone where suitable growing conditions for sesamum and groundnut are found. There, too, is the major production of pulse and fiber crops. The bulk of all food crops, other than rice, is produced in the Dry Zone and along the periphery of the Dry Zone and the Delta. Table VIII-1 shows the approximate acreage devoted to different agricultural crops in Burma.

A few agricultural commodities are imported into Burma, and the increased production of some of these is of considerable importance to the national economy. Principal among these are edible oils and sugar. Among fibers, long staple cotton is produced in insufficient quantities to supply local demands, while short staple cotton is exported for lack of milling facilities. Jute importation has been costly. An analysis of that situation is discussed in detail in the Project Report which indicates that jute bags can be manufactured in Burma from native jute for K67/ton less than they can be imported, but that the net revenue to the cultivator for jute fiber may not exceed that for paddy since man-hours of labor required per acre are at least twice those for paddy production. In addition, the advantage gained in the reduction of jute imports is counterbalanced by the loss due to the reduction of exports of rice previously grown on the land allocated to jute production.

d. Grazing

The importation of dairy products is large and will probably continue to be so for a long time. In spite of apparently good conditions for livestock production, as evidenced by reasonably abundant grazing lands on the Shan Plateau, the industry never developed in relation to other agricultural progress. Major reasons probably lie in the dominating interest of cultivators

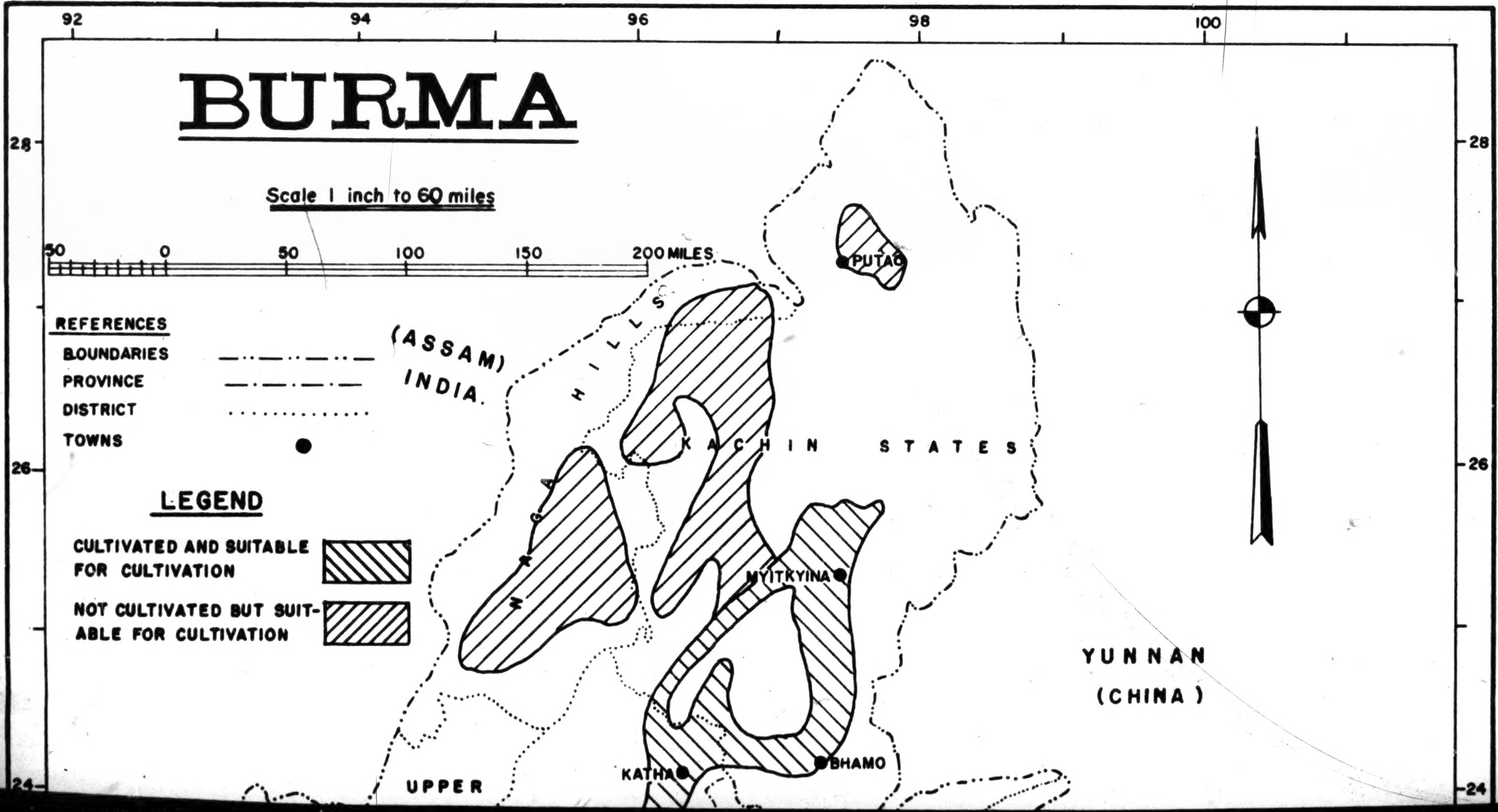
TABLE VIII – 1

ESTIMATED CROP ACREAGE BY DIVISIONS

Division	*Rice*	*Groundnut*	*Pulses*	*Sesamum*	*Millet*	*Maize*	*Cotton*	*Tobacco*	*Fruit and Other*	*Sugar Cane*	*Not Listed*	*Total*
1	978,400	—	1,000	1,800	100	400	800	7,900	30,700	—	46,100	1,067,200
2	3,760,000	1,600	29,300	14,300	—	5,300	2,700	24,100	159,200	11,900	151,400	4,159,800
3	3,549,500	8,700	50,900	3,000	—	26,400	—	18,000	147,500	—	174,500	3,978,500
4	1,394,100	—	3,300	7,400	—	300	—	4,800	219,900	11,400	73,300	1,714,500
5	384,600	362,600	101,100	350,800	134,400	81,400	55,100	20,700	12,100	—	294,100	1,796,900
6	630,500	282,500	340,200	387,500	151,300	49,200	133,300	12,900	58,800	20,800	77,900	2,144,900
7	1,097,800	101,700	431,400	287,900	141,200	10,400	185,000	12,400	25,600	7,900	223,300	2,524,600
												17,386,400

1. Akyab, Arakan Hills, Kyaukpyu, Sandoway.
2. Pegu, Tharrawaddy, Rangoon, Hanthawaddy, Insein, Prome, Toungoo.
3. Bassein, Henzada, Myaungmya, Maubin, Pyapon.
4. Salween, Thaton, Amherst, Tavoy, Mergui.
5. Thayetmyo, Minbu, Magwe, Pakokku, Chin Hills.
6. Mandalay, Kyaukse, Meiktila, Myingyan, Yamethin.
7. Bhamo, Myitkyina, Shwebo, Sagaing, Katha, Upper Chindwin, Lower Chindwin.

BURMA


Scale 1 inch to 60 miles
50
0
50
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150
200 MILES
REFERENCES
BOUNDARIES
PROVINCE
DISTRICT
TOWNS
LEGEND
CULTIVATED AND SUITABLE FOR CULTIVATION
NOT CULTIVATED BUT SUITABLE FOR CULTIVATION
92
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100
28
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(ASSAM) INDIA.
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PUTAO
MYITKYINA
BHAMO
KATHA
UPPER
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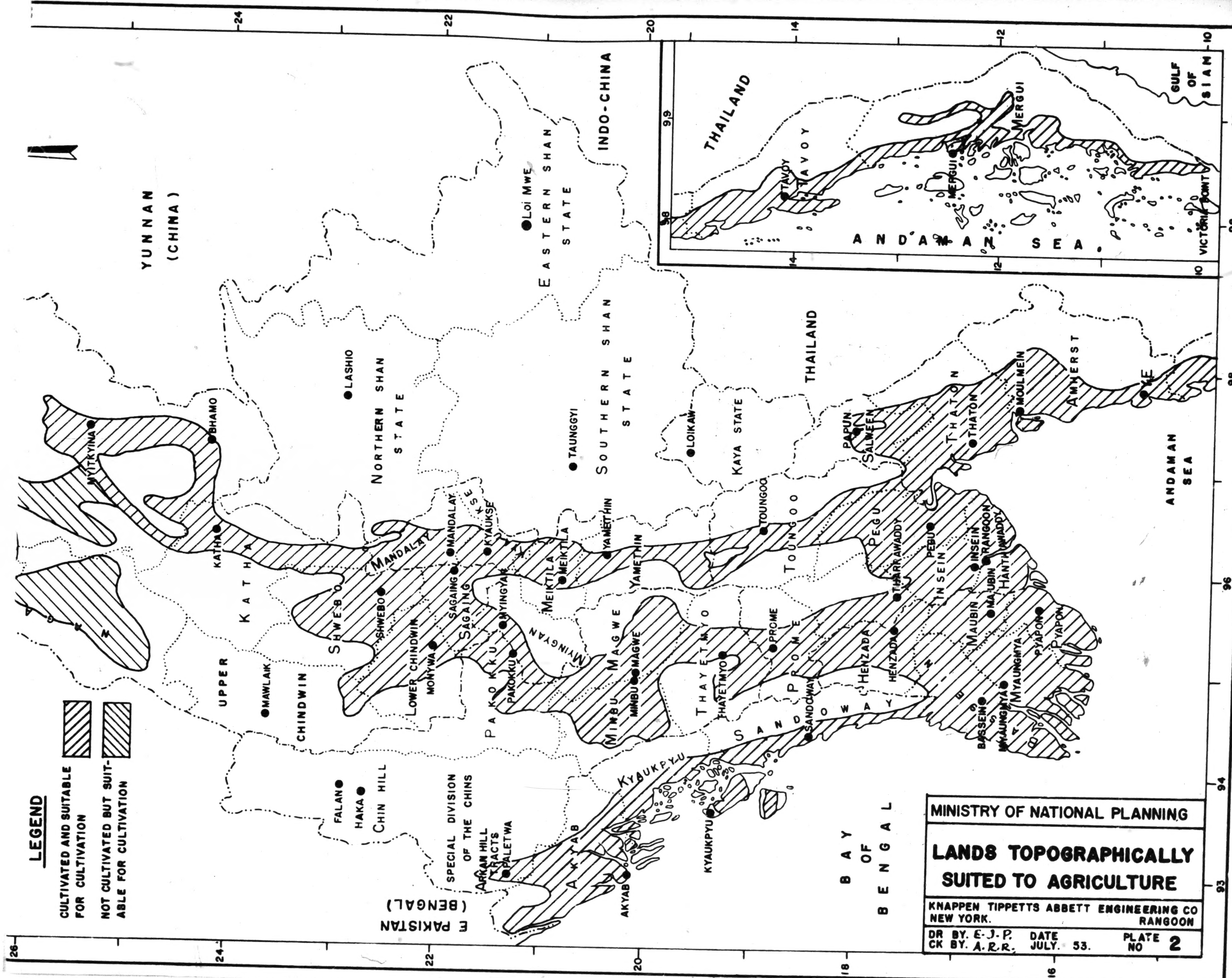

LEGEND
CULTIVATED AND SUITABLE FOR CULTIVATION
NOT CULTIVATED BUT SUITABLE FOR CULTIVATION
YUNNAN (CHINA)
INDO-CHINA
THAILAND
E PAKISTAN (BENGAL)
BAY OF BENGAL
ANDAMAN SEA
GULF OF SIAM
EASTERN SHAN STATE
NORTHERN SHAN STATE
SOUTHERN SHAN STATE
KAYA STATE
UPPER CHINDWIN
CHIN HILL
SPECIAL DIVISION OF THE CHINS
ARAKAN HILL TRACTS
Loi Mwe
LASHIO
BHAMO
MYITKYINA
KATHA
SHWEBO
MANDALAY
KYAUKSE
SAGAING
MONYWA
LOWER CHINDWIN
MYINGYAN
PAKOKKU
MEIKTILA
YAMETHIN
TAUNGGYI
LOIKAW
TOUNGOO
MAGWE
MINBU
THAYETMYO
PROME
SANDOWAY
HENZADA
THARRAWADDY
PEGU
INSEIN
RANGOON
HANTHAWADDY
MAUBIN
MYAUNGMYA
BASSEIN
PYAPON
SALWEEN
PAPUN
THATON
MOULMEIN
AMHERST
YE
TAVOY
MERGUI
VICTORIA POINT
KYAUKPYU
AKYAB
PALETWA
HAKA
FALAM
MAWLAIK
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MINISTRY OF NATIONAL PLANNING

LANDS TOPOGRAPHICALLY SUITED TO AGRICULTURE

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DR BY. E. J. P. DATE JULY. 53. PLATE NO 2
CK BY. A. R. R.

in cattle as draft animals instead of for meat or milk production and, more important, the difficulty of producing and maintaining livestock in the humid hot Delta country where agricultural production is concentrated. If livestock and dairy production are properly confined to the areas most suitable for their development, principally on the Shan Plateau, increased production of these commodities may be slow in developing because of the remoteness of that part of the country from the population centers.

e. Farming Methods

The very considerable exports of rice from Burma have been produced exclusively under primitive farming methods little changed from times of antiquity. The methods are characterized by the use of animal power, hand labor, and primitive tools. A description of rice cultivation throughout the year will explain farming methods in current use, and emphasize the possibilities for more efficient production and fuller land use.

Rice production is normally a two-stage operation consisting of nursery preparation followed by main paddy-field planting. Field nurseries comprise about 10% of the area to be planted, and they are the first to be prepared. Preparation begins after four to six inches of rain has softened the soil sufficiently to permit plowing with a steel-pointed wood plow. Plowing is completed toward the end of May or early June. The land is then harrowed using a timber crossbar equipped with teeth that stir up the soil in the manner of a pegtooth harrow. After the area has been harrowed eight or ten times, a simple rotary hoe is passed over it. Most of the soil preparation is carried out when there is one or more inches of water covering the surface. The inefficiency of the tools is partially responsible for the numerous repetitions required for each operation. One reason for repetitive plowing and harrowing is to "puddle" the soil into a thick mud that tends to seal the surface inches by destruction of the soil structure, thereby decreasing its permeability. The result is less leaching, or percolation, and a consequent reduction in the amount of irrigation water required.

Before field nurseries are planted, the water is drained, and seed, previously sprouted, is broadcast by hand. Sprouted seed establishes itself more readily than dry seed and is therefore less likely to be washed out by torrential monsoon rains. Water is gradually flooded into the nursery field plot, increasing in depth as the seedlings grow. After a period of four to six weeks the seedlings are ready to be transplanted.

While the nursery plot is growing, the main field is prepared for transplanting. Soil preparation on the main area is usually inferior to that on the nursery plot. Early rains encourage a fairly rank, hydrophytic weed growth of sedges and grasses that make soil preparation difficult.

When the soil is a thick mud in the upper four or five inches, and with three inches of water on the surface, the transplanting operation begins. Seedlings are pulled and tied into bundles, five or six hundred of which are required for one acre. After pruning, the seedlings are placed into the mud in bunches of two to four at six-inch intervals. Rarely, when labor or weather conditions dictate, sprouted seed is broadcast on the entire field in quantities of 60 or 80 pounds per acre, instead of transplanting.

After transplanting has been completed, no care is required for the crop other than regulation of water. About ten days before harvesting, the water is drained off the fields. The removal of surface water causes the rice plants to undergo a physiologic change that hastens ripening of the grain and discourages lodging.

Harvesting is sometimes preceded by laying the crop over in a single direction to prevent haphazard blowing over by the wind and to facilitate cutting. The crop is reaped with hand sickles by removing the panicle together with the top foot or so of culm. A long stubble is left in the field and usually later burned. Bundles of panicles are left on the threshing floor for a week or longer for drying. Bullocks tread the grain out of the plants and it is afterwards winnowed to separate the grain and chaff.

The production of a single rice crop occupies most of the year. Nursery preparation usually extends from the middle of May until the first of July. Transplanted in July, the crop matures in November or December. Harvesting takes place in January or February, the fields are burned in March or April, and in the following month soil preparation begins again. The graph below shows the normal rice cultivation pattern during the period of a year. With primitive equipment, plowing is possible only during the months of May and June. Hand harvesting occupies the month of January and often February.

M	J	J	A	S	O	N	D	J	F	M	A
Soil Preparation			Growing Season				Harvesting			Fields Burned	

In the absence of ample water at all seasons of the year, and unless there can be a reduction in the time required for plowing and harvesting, single cropping cannot be avoided.

3. PRESENT LAND TENURE

The development of commercialized paddy agriculture in lower Burma started with the British occupation and brought with it western institutions of land ownership, rule by law, and a money economy based on prevailing *laissez faire* notions. Production for the market required larger holdings than subsistence production and larger holdings required more labor and equipment. These in turn became cash costs to the cultivator. So long as rice prices increased and new rice lands were available, money for further rice area development was readily available and cultivators found it profitable to borrow. However, by 1908 and 1909, special inquiry into the conditions of the agricultural population in lower Burma concluded that small landholders were losing their lands to money-lenders, traders and large landlords. The land boom resulting from the sustained rise in the price of paddy and the availability of credit from the Chettyars collapsed as a result of the worldwide collapse of credit in 1907. The small cultivator unable to meet the sudden demand for repayment of his debts was forced to surrender his land. Since then there has been a steady decline in the area owned by cultivators. This trend was accelerated substantially during the depression of the early 'thirties and by 1939 in lower Burma 48% of the occupied area was occupied by non-agriculturists and 59% was under tenancy. In the worst districts 70% of the area was in the hands of non-agriculturists.

The commercialization of agriculture in upper Burma started much later than in lower Burma with the rapid expansion of groundnut production from about 1905. The result is that traditional patterns of village life have been better preserved. Farms are smaller in size, and, because of varied climatic conditions, agriculture is more diversified. Landlords usually live in the village or close by, and are often fellow farmers renting out surplus land. Problems of tenancy, indebtedness, and alienation of land did not reach the proportions that they did in lower Burma. Tenancy litigations were more infrequent than in lower Burma and apparently tenants were relatively satisfied with their lot. However, while the increase in tenanted area and in the area of land held by non-agriculturists started much later in upper Burma than in lower Burma the rate of increase has been roughly as indicated in the graph (see Plate 3). Most studies quote data on area held by non-agriculturists to indicate the seriousness of the tenancy problem, but the area under tenancy is much greater in upper Burma than indicated by the area held by non-agriculturists because of the large proportion of tenant land held by agriculturists. By 1939 only 14·2% of the land in upper Burma was owned by non-agriculturists but 32·5% of the land was tenanted. Plate 4 indicates the proportion of land in the various tenure categories. Tables VIII–2, 3 and 4 show occupancy of land in lower Burma, upper Burma and in the whole of Burma respectively.

TABLE VIII – 2

OCCUPANCY OF LAND IN LOWER BURMA

(*in acres*)

Year	*Total Occupied Area*	*Tenanted Area*	*Total Non-agriculturist*	*Resident Non-agriculturist*
1925–26	10,339,589	4,482,835	2,784,959	700,163
1926–27	10,456,422	4,583,092	2,893,219	735,723
1927–28	10,607,514	4,626,601	2,955,433	767,131
1928–29	10,654,025	4,701,952	3,052,816	778,345
1929–30	10,745,121	4,932,361	3,231,561	803,617
1930–31	10,805,961	5,264,090	3,513,936	821,585
1931–32	10,733,754	5,290,692	4,093,594	857,232
1932–33	10,768,444	5,773,249	4,473,817	834,843
1933–34	10,846,462	5,981,012	4,816,071	860,493
1934–35	10,926,303	6,225,308	5,061,753	890,052
1935–36	11,056,018	6,372,425	5,253,082	968,161
1936–37	11,201,766	6,579,507	5,306,017	989,419
1937–38	11,300,110	6,683,797	5,359,823	981,684
1938–39	11,293,092	6,682,233	5,385,150	966,968
1945–46	11,330,885	3,383,460	5,435,285	1,017,813
1946–47	11,330,243	4,684,726	5,400,483	974,716
1947–48	11,391,237	5,366,836	5,492,666	949,560
1948–49	7,647,288	3,699,942	3,784,276	655,134
1949–50	10,402,581	4,645,683	5,095,891	891,598

Source: Report of the Land and Agricultural Committee. Report on the Land Revenue Administration of Burma (Statement XI).

TABLE VIII – 3

OCCUPANCY OF LAND IN UPPER BURMA

(*in acres*)

Year	*Total Occupied Area*	*Tenanted Area*	*Total Non-agriculturist*	*Resident Non-agriculturist*
1925–26	7,932,229	1,924,299	686,909	312,347
1926–27	7,928,498	2,014,173	686,411	310,758
1927–28	7,912,922	1,915,007	720,497	327,936
1928–29	7,892,047	2,010,208	731,073	324,552
1929–30	8,002,805	2,158,070	797,105	350,671
1930–31	8,007,426	2,160,320	842,700	368,866
1931–32	8,021,272	2,167,279	908,230	394,425
1932–33	8,049,372	2,387,997	982,473	424,273
1933–34	8,049,951	2,553,608	1,035,326	441,857
1934–35	8,066,490	2,623,823	1,076,780	454,298
1935–36	8,093,082	2,646,076	1,105,521	462,623
1936–37	8,103,141	2,698,094	1,136,016	475,745
1937–38	8,143,036	2,680,403	1,153,816	482,428
1938–39	8,167,666	2,654,033	1,157,944	481,350
1945–46	7,921,959	1,795,333	1,065,932	458,471
1946–47	7,830,976	1,770,093	1,003,849	428,710
1947–48	7,873,527	1,973,731	985,047	419,625
1948–49	5,189,216	1,269,899	644,361	285,451
1949–50	8,065,241	1,899,880	984,553	426,689

Source: Report of the Land and Agricultural Committee. Report on the Land Revenue Administration of Burma (Statement XI).

TABLE VIII – 4

OCCUPANCY OF LAND (TOTAL BURMA)

(*in acres*)

Year	*Total Occupied Area*	*Tenanted Area*	*Total Non-agriculturist*	*Resident Non-agriculturist*
1925–26	18,271,818	6,407,134	3,471,863	1,012,505
1926–27	18,384,920	6,597,265	3,579,630	1,046,481
1927–28	18,520,436	6,541,608	3,675,930	1,095,067
1928–29	18,546,072	6,712,160	3,783,889	1,102,897
1929–30	18,747,926	6,985,431	4,028,666	1,154,288
1930–31	18,813,387	7,424,410	4,356,636	1,190,451
1931–32	18,755,026	7,457,971	5,001,824	1,251,657
1932–33	18,817,816	8,161,246	5,456,298	1,259,116
1933–34	18,896,413	8,534,620	5,851,397	1,302,350
1934–35	18,922,793	8,849,131	6,138,538	1,344,356
1935–36	19,149,100	9,018,501	6,358,603	1,430,784
1936–37	19,304,907	9,277,601	6,442,033	1,465,164
1937–38	19,443,146	9,364,200	6,513,594	1,464,112
1938–39	19,460,758	9,336,236	6,543,094	1,448,318
1945–46	19,252,844	5,178,793	6,501,217	1,476,284
1946–47	19,161,219	6,454,819	6,404,332	1,403,426
1947–48	19,264,764	7,340,567	6,477,713	1,369,185
1948–49	12,836,504	4,969,831	4,428,637	940,385
1949–50	18,467,822	6,545,563	6,080,444	1,318,287

Source: Report of Land and Agricultural Committee. Report on the Land Revenue Administration of Burma (Statement XI).

The lot of the tenant farmer was not enviable. Rents ranged from about 25% to 60% of the crop. At the end of the season after paying his rent and his debts the tenant farmer normally did not have enough "wunza," the paddy to be used for food during the coming year. Particularly in lower Burma, where fixed rents prevail, a poor crop usually meant accumulation of debts and eviction from the land. Prewar studies in lower Burma show that only about half the tenants remained on a given piece of land for more than one year and that less than a quarter remained for more than four years.

The average size of a holding in lower Burma is now between 10 and 20 acres, or the area which can be plowed with one or two yokes of oxen. Some cultivators operate as much as 50 acres which is the maximum permissible under the Disposal of Tenancies Act, but the postwar tendency has been toward smaller holdings. In Upper Burma, holdings are much smaller, averaging between five and ten acres.

4. AGRICULTURAL PRODUCTION

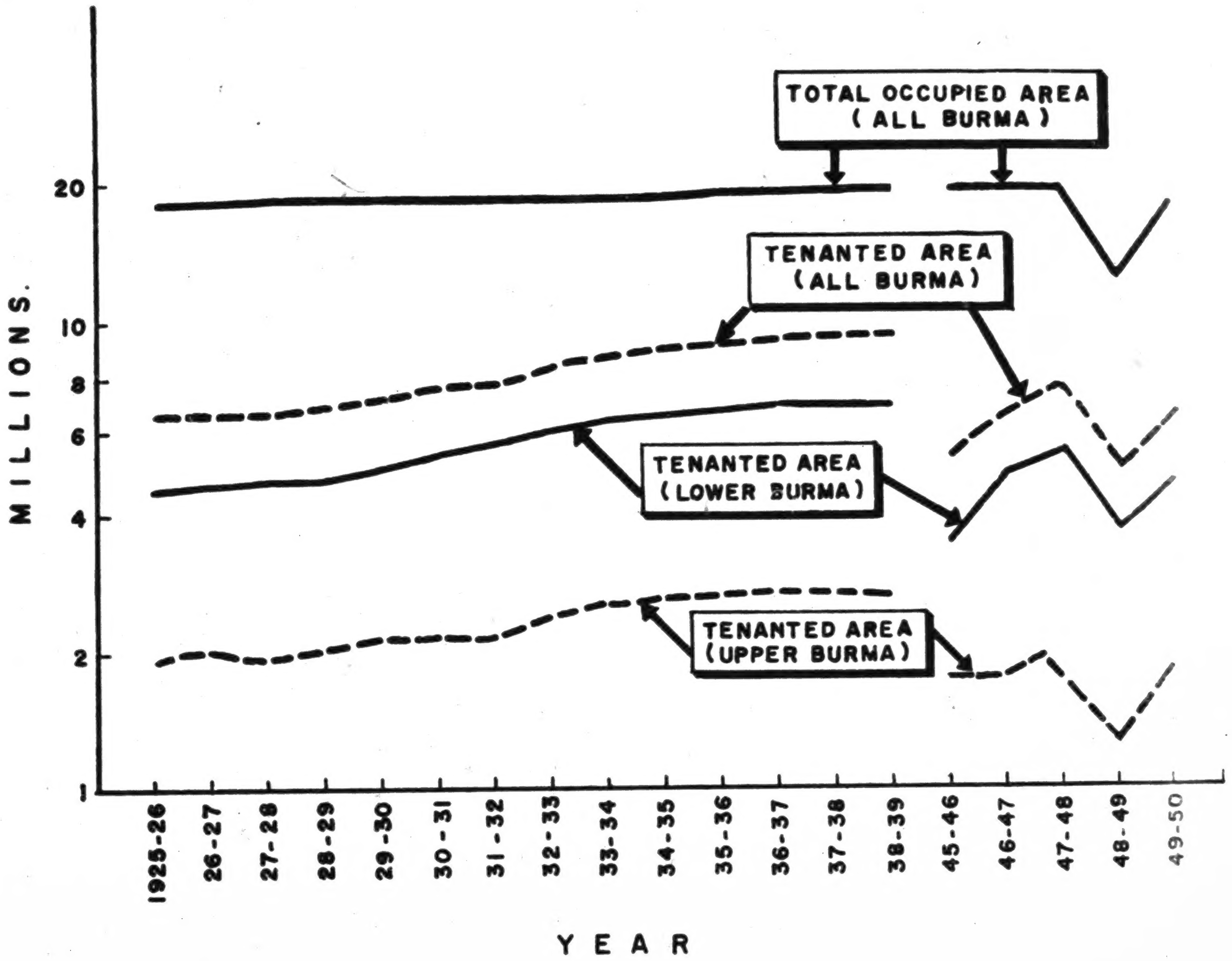
The total area under crops and output in the prewar and postwar periods are shown in Tables VIII–5 and 6. During the war, incentive to produce was low and many export crops in 1945–46 fell to

TABLE VIII – 5

SOWN ACREAGES, PREWAR AND POSTWAR

	Average 1936–37 to 1940–41	*1938–39*	*1946–47*	*1947–48*	*1948–49*	*1949–50*	*1950–51*	*1951–52*	*1952–53*
				A. In thousands of acres					
Total Acreage Sown	*19,117*	*18,990*	*13,456*	*15,305*	*15,783*	*15,031*	*15,120*	*15,366*	*16,270*
1. Paddy	12,832	12,816	8,242	9,597	10,128	9,349	9,467	9,698	10,331
2. Groundnut	808	840	573	729	706	699	695	721	744
3. Sesamum	1,401	1,363	1,262	1,395	1,385	1,351	1,297	1,321	1,328
4. Cotton	453	408	171	222	219	216	221	255	294
5. Pulses	1,329	1,347	852	970	968	995	1,000	950	1,050
6. Sugar Cane	64	59	38	46	56	45	45	50	60
7. Millet	475	456	603	565	583	589	635	598	682
8. All Other Crops	1,755	1,701	1,715	1,781	1,738	1,787	1,760	1,773	1,781
				B. As per cent of prewar average					
Total Sown	*100*	*99*	*70*	*80*	*83*	*79*	*79*	*80*	*85*
1. Paddy	100	99	64	75	79	73	74	76	81
2. Groundnut	100	104	71	90	87	87	86	89	92
3. Sesamum	100	97	90	100	99	96	93	94	95
4. Cotton	100	90	38	49	48	48	49	56	65
5. Pulses	100	101	64	73	73	75	75	71	79
6. Sugar Cane	100	92	59	72	88	70	70	78	94
7. Millet	100	96	127	119	123	124	134	126	144
8. All Other Crops	100	97	98	101	99	102	100	101	102

TENANTED AREA



Source :- Report of the Land and Agriculture Committee.
Report on Land Revenue
Administration of Burma.

MINISTRY OF NATIONAL PLANNING.

TENANTED AREA

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CK. BY. J.L. JULY. 53. NO. 3

TABLE VIII - 6

AGRICULTURAL PRODUCTION, PREWAR AND POSTWAR

	Average 1936–37 to 1940–41	*1938–39*	*1946–47*	*1947–48*	*1948–49*	*1949–50*	*1950–51*	*1951–52*	*1952–53*
	A. In thousands of tons								
1. Paddy	7,426	8,050	3,968	5,535	5,264	4,691	(4,979)	(5,250)	5,740
2. Groundnuts	181	180	103	153	144	115	145	176	176
3. Sesamum	45	53	32	44	42	32	39	48	54
4. Cotton	20·5	18·8	3·9	7·7	7·7	7·1	7·7	6·9	9·2
5. Pulses	217	198	153	188	187	175	183	177	181
6. Sugar Cane (1,000 canes)	560	520	356	344	355	300	304	360	384
7. Tobacco	38	31	36	46	43	40	47	45	46
8. Millet and Wheat	70	67	58	77	84	56	76	71	77
	B. As per cent of prewar average								
Index of Total Agricultural Production	100	106	56	77	74	65	70	75	81
1. Paddy	100	109	54	75	71	63	67	71	77
2. Groundnuts	100	100	57	85	80	64	80	97	97
3. Sesamum	100	118	71	98	93	71	87	107	120
4. Cotton	100	92	19	38	38	35	38	34	45
5. Pulses	100	91	71	87	86	81	84	82	83
6. Sugar Cane	100	93	64	61	63	54	54	64	69
7. Tobacco	100	82	95	121	113	105	124	118	121
8. Millet and Wheat	100	96	83	110	120	80	109	101	110

subsistence levels. The biggest fall in production was in cotton. Paddy output fell to 54% of the prewar level. The index of total agricultural production was down to 56% of the prewar base. In spite of the insurrections, acreage and output in 1952–53 are now 85% and 81% respectively of the prewar level. Progress is registered by all major indicators: acreage, output and yields. The 10,331,000 acres of paddy sown in 1952–53 represent a postwar high. The production of 5·7 million tons of paddy in 1952–53 is also the highest in the postwar period.

On the other hand, although the average yield per acre of paddy over the last five years is 91% of the five-year prewar average, the yields remain far below what they should be with the employment of scientific agricultural practices, as will be discussed in succeeding paragraphs.

5. AGRICULTURE PROBLEMS

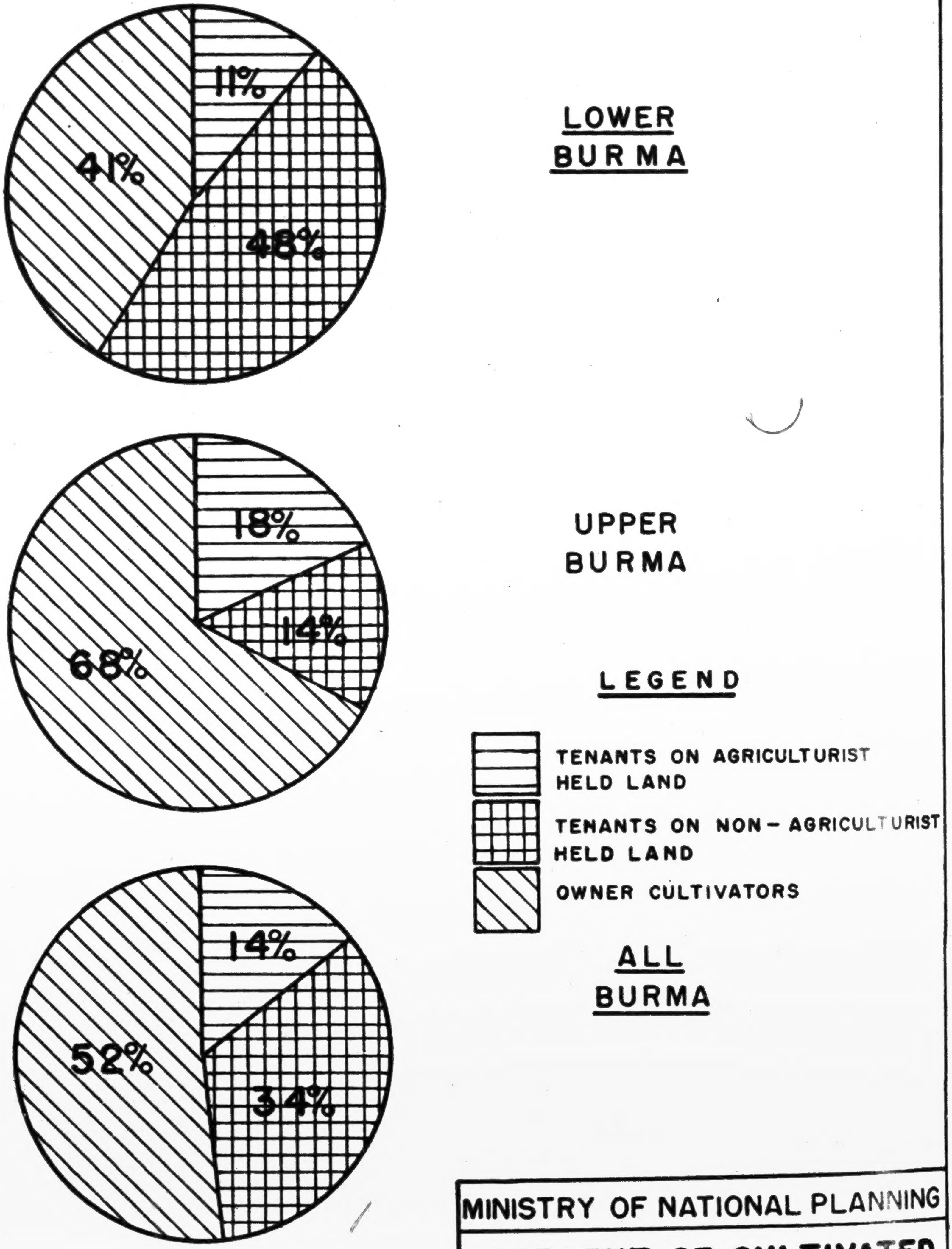
a. Low National Output

The collective ills of the nation's agriculture are reflected in the low national output. The most conspicuous index of low national output is the difference between prewar and postwar rice exports. The present export of rice is only 41% of the prewar quantity, and the efforts of Government are directed toward reaching the former rice export volume. Insurgency is a factor profoundly affecting agricultural production by denying the normal cultivation of some areas.

b. Low Per-unit Yields

Agricultural production is at a low level of per-unit yield in every crop grown. In most areas, the soil has reached its base level of productivity. Primitive cultivation has puddled the surface soil of the entire rice-producing area, creating conditions unfavorable for all crops other than rice. Paddy monoculture, with its deleterious effect of exhausting the nitrogen and phosphorus reserves in the soil, is the rule. Little or no fertilizers, organic or otherwise, are applied. The undesirable custom of burning paddy lands is probably made necessary by the absence of sufficient nitrogen in the soil to supply body-building material for the soil microorganisms required to reduce stubble to a humus condition. Under present farming methods, the soil is not managed but mined, with resulting continued degeneration and progressively declining yields.

In spite of present low yields, there are factors very favorable to increased production. Some of the possibilities that appear to be practical and financially feasible for application in Burma are discussed in this Report.



Source = Report on Land Revenue Administration of Burma (1938-39)

MINISTRY OF NATIONAL PLANNING

PERCENT OF CULTIVATED LAND IN VARIOUS TENURE CLASSES

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c. Studies, Development and Education

Much work is needed in this field. Surveys, detailed plans, estimates, research, and various educational measures are required. As first steps of the development of new land, the program of aerial mapping should be carried to conclusion, and a broad program of land classification surveys initiated. On the basis of information obtained from these sources, plans may be made for the clearing and preparation of new land and for the development of irrigation and drainage where required. Experimental and demonstration farms are needed for developing the practical adaptation of new methods of cultivation, application of fertilizer, new crop varieties, new methods of pest control, and related measures. Demonstration farms may be used to test the application of various mechanical farming aids, and, as an adjunct to the extension services, to provide a training and instruction ground with which to introduce these measures to the interested population.

d. Fiscal and Marketing Problems

An important reason for low incomes in agriculture has been the large share of total output which has gone to non-agriculturists in the form of rents, interest and trading profits. The Burmese Government has taken steps to correct this inequity through rent controls, land nationalization, government loans, formation of cooperatives, and establishment of state and cooperative marketing. Most of these measures have not yet been fully implemented and some are not consistent with the objectives of increasing output. Also, in the past, heavy rent and interest burdens have reduced the farmer's standard of living and denied him the incentive or opportunity to increase production. Insecure tenure conditions have tended to discourage land improvement practices. The lack of proper market information and the lack of uniform standards of weights and measures and grades have prevented farmers from obtaining full market prices for their produce. Tax measures have not been framed with adequate consideration for the tax burden of the cultivator and its relationship to production incentives.

C. NATIONAL AGRICULTURAL PROGRAMS

1. THE LAND NATIONALIZATION PROGRAM

The Burmese Government, in recognition of the need for basic institutional changes in Burma's land tenure system, passed a series of laws to provide some early relief from tenancy, and the Land Nationalization Law which will, when implemented, eliminate tenancy on all privately owned land. Steps to implement the Land Nationalization Act have, however, been delayed as a result of the insurgency. To date only a small area in Syriam has been nationalized.

The Burmese Constitution provides that the State is the owner of all land. The Land Nationalization Act carries out this philosophy by providing for resumption by the State of land in excess of specified limits and distribution of the land to cultivators and laborers who would operate the land as state tenants. The Act provides that recipients of land must become members of cooperative societies which would be formed as part of the program. The stated long-term objective is to encourage either cooperative or collective farming. In the first phase it is planned to distribute about 9,900,000 acres of land in parcels which can be plowed with one yoke of oxen. To assure maintenance of adequate living standards, cottage industries, poultry farming, livestock, and cooperative farming or collective farming are to be introduced where necessary.

The short-term program to improve conditions of tenancy before implementation of the Land Nationalization Act consists of the Disposal of Tenancy Acts, the Rent Control Acts and the Land Alienation Act. The Land Alienation Act prohibits transfers of agricultural land to non-agriculturists, and has halted the prewar trend toward increased ownership of land by non-agriculturists. The Rent Control Acts limit gross rents to twice the land revenue tax on paddy land, 20% of out-turn on Ya (field crops other than rice) lands, and 10% of out-turn on sugar cane land. The Disposal of Tenancies Act guarantees the tenure of a tenant so long as he pays standard rents, has not defaulted in the repayment of agricultural loans, and cultivates the land. The Act also limits cultivators to cultivation of 50 acres of paddy or equivalent.

These laws have given tenants most of the advantages of land ownership in areas where they have been enforced. Rents are nominal and tenure is secure. The main problem is that a tenant has no land to mortgage and has difficulty in getting credit. These conditions would of course also be true after nationalization so that in areas where tenancy laws are enforced there is little interest in land nationalization. However, enforcement of tenancy laws is by no means thorough or widespread. In addition to insurgent-held areas there are many areas, particularly in upper Burma, where farmers know very little about the laws. In a number of villages tenants are still paying traditional rents in excess of legal maximums. Tenure was insecure and Tenancy Disposal Boards were inactive because tenants did not know their rights under the law.

However, even if the laws are more fully enforced, so long as tenancy exists on a large scale the

possibilities of reverting to the old system of rack renting and insecure tenure will remain. So long as the demand for land exceeds the supply at controlled rents there will be incentives for evasion of controls. Rental contracts can be changed to sales contracts. Evictions are legally possible under some circumstances, and Tenancy Disposal Boards are not infallible. Hence the objective of the Government to eliminate tenancy should be enforced. In the meantime every effort should be made to publicize and enforce the present temporary laws.

The present plan of the Government, as expressed in Resolutions adopted by the Welfare State Conference in August, 1952, and various speeches by the Minister of Land Nationalization, describe as the ultimate goal of the program the establishment of large-scale collective and cooperative farms. The nationalization of land and its distribution to State tenants as one-yoke plots is considered to be only a temporary phase of the program. Reduction in the size of tenant-managed farms to more or less equal units is expected to minimize opposition to later collectivization and at the same time to provide land for distribution to landless laborers. The problems involved in sub-dividing holdings and the adverse effects on production of disturbing present management units are considered by the officials concerned to be of relatively little consequence as compared to the long-range advantages to be gained through collective farming.

Plans for establishment of one collective in 1954, seven in 1955, and 66 more between 1956 and 1962 are included in the ten-year plan for land nationalization prepared by the Ministry of Land Nationalization. However, Burma has had no experience in collective farming and very little experience in mechanized farming. Substantial investment of equipment and technicians will be required and a number of collectives will have to be established before their success or failure can be fully determined. If the experimental collectives should prove successful the program can be accelerated. The recent experience of Yugoslavia and the earlier Russian experience indicate that many difficulties are encountered in the initial stages of collectivization. Yugoslavia is no longer encouraging collectives and has decided to carry through a program for cooperative farming based on smaller individual holdings. The USSR also has had to revert to individually operated farms until enough experience and technical skills in collective farming can be developed.

In the process of dividing resumed land into one-yoke plots, tenants operating more than one yoke will be adversely affected and may resist. Problems of providing cattle and equipment for the new cultivators are created, and problems of surveying and distributing the land are increased substantially over those involved in simply continuing the tenant operator on the land he farms. In addition, disturbances of present management units will probably reduce output until cultivators get accustomed to their new holdings.

To achieve action without encountering these initial difficulties, it is recommended that the initial phase of the program should be limited to elimination of absentee ownership of tenant land and distribution to present tenant cultivators. This step can be taken without disturbing production, and can be carried out with much less administrative expense than a more ambitious program. This step will legalize the "*de facto* land reform" in lower Burma and establish a cutoff date on any claims which landlords may press on the tenant in the future for unpaid rents. It will greatly improve the economic status of tenant farmers in upper Burma. It will give concrete assurance to farmers that Government has abolished the old system of rack renting and insecure tenure, and make farmers more amenable to cooperation with the Government in other phases of the program to increase farm income.

The purchase of owner-operated land in excess of 50 acres should be carried through. The Disposal of Tenancies Act has already reduced the size of holdings to this level in areas where it has been enforced. Before its enactment, less than 2% of the holdings were in excess of 50 acres. The amount now is probably much less, and purchase of such lands should not create any special administrative problems.

In terms of long-range development of agriculture, mechanization can be expected to play an increasingly important role. The 50-acre limit on individual holdings is a real deterrent to the development of mechanized agriculture on a privately managed basis. This is one of the important reasons why the Burmese Government plans to establish collective or cooperative farms. If the formation of cooperative or collective farms progresses slowly, and if the Government desires to attract private capital for agricultural development, it is recommended that exceptions to the 50-acre limit be permitted where a cultivator has equipment necessary for mechanized farming and if there are surplus lands available, or that individual holders be encouraged to farm their holdings jointly under a cooperative arrangement. The Government should screen each application for oversized farms carefully to determine that the applicant has sufficient capital and a sound farm plan. Periodic checks should be made to insure that proper labor standards are being observed and that productive efficiency is being maintained. Private capital may be of value in opening up new areas or in restoring abandoned land which cannot be cleared without mechanical equipment.

The Act provides for exemption of lands owned by "agriculturists" within the limits of 50 acres of paddy or caneland, 25 acres of Ya land or ten acres of Kyaing land from resumption by the State. The Act has very tight provisions for resumption of land held by non-agriculturists but will permit agriculturists to retain tenanted land within the authorized limits on condition that they cultivate the land themselves. This will mean that tenants on land held by agriculturists will be forced off the land and will become landless laborers. While this will not be a major problem in lower Burma where the bulk of the tenanted area is held by non-agriculturists it will result in a substantial change in upper Burma where there are at least 1½ million acres of tenanted land held by agriculturists.

To maximize production, and to speed the land nationalization program, it is recommended that efforts be made to minimize changes in the management unit and to concentrate on changes in landholding rights. The importance of speedy implementation of a simplified land nationalization program cannot be overemphasized. Landlords have not yet fully re-established their controls over their tenant lands and are probably less likely to resist now than they would be at a future date when they have re-established control. Delays will also give landlords added opportunities to evade nationalization through sales to tenants. Also, the longer the delay the more difficult it will become to determine the status of landholders on January 4, 1948, which is the basis for determining which lands are to be resumed and who qualifies as an agriculturist.

The program for land nationalization as outlined in the ten-year plan is an ambitious program which attempts to carry through a thorough-going reform of the Burmese agrarian structure. It includes not only changes in land tenure, but also formation of producer cooperatives, improvement of agricultural production methods, settlement of new agricultural land, formation of mechanized collective farms, and machine and tractor stations, diversification of agriculture, establishment of village processing and institution of collective purchasing and marketing. The first phase of the program consists primarily of basic research and training of personnel. Part of this work has been done but the major part of the work remains.

The idea that reforms in land tenure alone are only a partial solution to the problems of improving the economic status of the cultivators is sound. However, reforms in land tenure need not wait upon reforms in other fields. Development of agricultural cooperatives, use of improved production methods, large-scale mechanization, and realization of other goals will require many years of intensive work. The Co-operative Department and the Department of Agriculture are currently engaged in programs aimed at some of these goals. The land nationalization program should be integrated with these programs.

2. THE FIVE-YEAR PLAN FOR AGRICULTURAL SELF-SUFFICIENCY AND DEVELOPMENT

In order to increase agricultural exports and to provide a greater degree of self-sufficiency the Burmese Government prepared a Five-year Plan for Agricultural Development in 1952. The plan contains projects for increasing the annual output of farm products by K1,15,00,00,000 by 1959–60. Implementation of the plan is expected to bring about fuller employment of resources, increased incomes, a higher level of consumption and increased foreign exchange. Specific targets are shown in Table VIII–7 (*see p.* 138).

To carry out the projects the Agricultural and Water Resources Development Corporation was established with an initial grant of K1 crore. The Corporation is responsible for coordinating the operations of various agencies involved in implementing projects under the plan and for disbursement of funds required to finance the projects.

Nine projects were selected for immediate implementation. The program for the restoration of prewar levels of rice exports was given the highest priority. Programs for increased production of groundnuts, long stapled cotton, jute, coconuts and onions were also given high priority. Establishment of an experimental state dairy farm and a cattle breeding farm was also planned. Immediate steps for establishment of a State Agricultural Bank were also approved.

During 1952–53 the Corporation distributed subsidies of K43,78,000 to farmers for bringing new paddy acreage into cultivation. In 1952 the target acreage of 505,000 acres was exceeded by 128,000 acres. K14,73,000 was also distributed for extension of groundnut crop acreage.

Two thousand acres of land have been cleared in the Thapan Cotton Seed Farm site at Meiktila. Cattle purchase and cultivation loans have been distributed to tenants in that farm. They will grow long stapled cotton for the Government Spinning and Weaving Factory. An additional 2,000 acres will be brought into cultivation next year.

The Corporation has loaned K15,000 to jute seed growers in 1952. The 1953 jute acreage goal was reduced from 10,000 acres to 7,200 acres as the 1952 output of seed fell short of expectations. K3,25,000 has been allocated for loans to growers for planting the main jute crop.

TABLE VIII – 7

TARGETS OF INCREASE IN AGRICULTURAL INCOME BY 1959

(value expressed in 1951–52 prices)

Projects	*Total Increase over 1952*		*Agricultural Income Increase from*			
	Production	*Agricultural Income*	*Extension*		*Improvement of Conditions for Growing or Living*	*Improvement of Productive Efficiency of Plants or Animals*
	000 *(Tons)*	000 *(K)*	*(Acres)*	*(K)*	*(K)*	*(K)*
A. AGRICULTURE AND FISHERIES						
1. Rice (74% of paddy)	1,750	3,50,000	*2,500 †500	3,00,000	40,000	10,000
2. Groundnut	150	75,000	*200	69,000	5,000	1,000
3. Cotton	10	10,000	*200	8,000	500	1,500
4. Pulse Crops (excluding soya beans)	100	15,000	*350	15,000	—	—
5. Soya Beans	25	4,000	†75	3,000	—	1,000
6. Sugar Cane	350	17,500	*†20	15,000	1,000	1,500
7. Onions	50	10,000	10	8,000	2,000	—
8. Spices (Chillies)	10	700	15	700	—	—
9. Wheat and Barley	50	15,000	250	14,000	500	500
10. Jute	—	4,000	70	4,000	—	—
11. Maize	12	3,500	*50	3,500	—	—
12. Tobacco	—	4,000	—	—	—	4,000
13. Tea	1	2,000	—	1,500	250	250
14. Coffee	0·2	1,250	—	1,000	100	150
15. Coconut	—	—	‡10	—	—	—
16. Vegetables	100	30,000	—	25,000	5,000	—
17. Livestock	750 (no.)	1,50,000	—	1,25,000	10,000	15,000
18. Dairy Products	10	10,000	—	5,000	1,000	4,000
19. Fish and Fish Products	20	25,000	—	20,000	5,000	—
20. Miscellaneous (Fruit, Tung oil, etc.)	—	1,00,000	—	80,000	10,000	10,000
Total		8,26,950		6,97,700	80,350	48,900
B. STATE MARKETING		3,20,000				
Grand Total		11,46,950				

*Rehabilitation and reclamation of land previously cultivated.
†Opening up of new land.
‡Full bearing only after 12 years.

Sindhi cows from Pakistan were imported for the dairy farm at Insein. This farm has now started production. Construction of buildings on the Taungdwingyi site for the cattle breeding farm has been started. The Corporation has also procured coconut seedlings from Penang and from domestic sources for planting 300,000 trees. Work was started on pump installations required for expansion of onion acreage.

A Directorate of State Agricultural Credit has been established to coordinate all government loans made to cultivators. The Directorate made arrangements necessary for the establishment of the State Agricultural Bank with branches in four districts. The Bank will issue loans to cultivators in these districts. In other districts the Bank will provide farmers with K3·77 crores in direct loans and K1·55 crores in cooperative loans. The total of government loans to agriculturists through various agencies will amount to K10·12 crores. This is more than double the amount issued in 1951–52. In addition to these loans special subsidies of K65,00,000 will be issued for acreage extension.

The results of the first year's operation of the Agricultural and Water Resources Development Corporation have been encouraging. With its small staff the Corporation has managed to expedite the flow of funds required for financing the priority projects in the Five-year Agricultural Development Plan and to meet most of the goals for the initial year. The Agriculture Department was responsible for execution of most of the projects in the field. Its excellent cooperation was an important factor in this success. The task was made relatively easy by the availability of large areas of abandoned land which were freed from insurgent disturbances.

3. FINANCING THE FARMER

A sound credit system for agriculture must be based on a prosperous and stable agricultural population. Sound loans can be made only where there is a basis for credit, a reasonable assurance that the borrower can repay the loan. This will in large measure depend on the borrower's capacity to earn. The shortage of credit on reasonable terms has forced farmers to borrow at interest rates ranging as high as 400% per annum. Farmers are prevented from adopting improved practices requiring cash outlays because funds are not available at more reasonable rates. It is therefore recommended that in addition to general measures recommended for raising the level of incomes in agriculture, a sound system of increased agricultural credit be made available to farmers.

a. Short-term Credit

The Committee on the State Agricultural Bank made a thorough study of the agricultural credit problem in 1948, and presented a report with detailed recommendations for meeting the seasonal agricultural credit problem. Subsequently, a Directorate of State Agricultural Credit has been established. A State Agricultural Bank with four district branches was established in 1953 with a capital of K5 crores.

Under the State Agricultural Bank plan, village banks will be established. Each village will elect a village bank committee of four to be headed by the village headman. The committee will be responsible for disbursing and collecting seasonal agricultural loans. The State Agricultural Bank will provide seasonal crop loans through the district branches to village banks at 6% interest. The village bank will lend to the cultivator at 12%, the difference being used to build up the capital of the village bank. Loans will be issued to cultivators on a flat per-acre basis until such time that village banks become sufficiently well established to balance loans with needs.

During the year 1952–53, the Bank expects to lend K5 crores in the four districts where branches will be opened. The loans will amount to K28 per acre in contrast to an average of about K7 per acre issued previously through direct government loans and cooperative loans. In addition in the districts with no banks, direct government loans amounting to K3·75 crores and cooperative loans amounting to K1·55 crores will be issued by the State Agricultural Bank. In addition K65 lakhs will be distributed as acreage increase subsidies in connection with the Five-year Plan. This will amount to a total of K10·7 crores as compared to estimates by Binns of seasonal loan requirements of K10 crores on the basis of paddy prices of about one third of the present level. In the areas where the Bank will operate it should be in a position to provide most of the required short-term financing, and free cultivators from the usurious rates charged on sabape loans. In other areas farmers would receive only a slight increase in per-acre loans. However, the increase in money in circulation in the economy resulting from increasing rice exports and from increasing development plan expenditures will provide considerably increased private credit available for agricultural loans.

In view of the present shortage of administrators and of the cultivators' inadequate understanding of the proper use of credit, it is desirable to start the Bank on a modest scale and to minimize red tape and the need for supervision. On the basis of the experience gained in the first years it will be possible to improve procedures and to open up additional district branches. Too ambitious a program in the first year could result in inefficient administration and failure to collect loans when due.

The principal obstacle to establishment of a sound farm credit system is the failure of farmers to understand the proper use of credit and the absence of responsible village organizations through which to channel credit. In the past, farmers have tended to look upon indebtedness as a normal condition of life. Money was borrowed not with the idea of putting it to productive use to increase incomes, but in order to meet personal expenses as well as productive costs. Little thought was given to the necessity of repayment with interest until the loans matured. The introduction of cooperatives was an attempt to build up responsible village organizations, but few members understood cooperative principles. Over-expansion of credit and failure to build up adequate capital resulted in widespread liquidations of cooperatives during the depression.

The Bank Committee Report recognizes these difficulties and emphasizes the need for insistence on prompt repayment of all loans in order to develop greater consciousness of the responsibilities of the borrower. However, this is not enough. An intensive program of information and education on the proper use of credit, on the need for savings, and on how and when to borrow should be instituted immediately. Likewise establishment of District Banks should be preceded by intensive programs to explain to cultivators the purposes of the banks, the benefits to be gained, the responsibilities to be assumed by cultivators, and detailed procedures for organization and operation of the Bank. When extension services have been established, this program should be reoriented to incorporate conditions and features relating to production methods, use of equipment and other factors affecting improved output.

The village bank should be promoted not only as a place to get loans but as an institution belonging to the villagers and which will provide benefits to just that extent to which villagers contribute to its success by prompt repayments and by contributions to capital. A financial stake in an organization stimulates interest. The present plan calls for a very gradual accumulation of capital by retention of profits in the village banks. In addition a program to compel cultivators to subscribe to capital at harvest in order to qualify for loans in the succeeding years should be considered. The amounts should be small enough not to be burdensome. Subscriptions of 5% or 10% of the amount borrowed would keep the total payments collected from the cultivator well below the prevailing interest rates.

Certain minimum financial standards should be established for village banks to insure sound operations. Some of the points which should be covered are establishment of minimum ratios of capitalization to volume of loans, and to fixed assets, accumulation of minimum reserves, maximum loans to individual members, and standards for loan security. Some of these standards cannot be enforced initially but village banks should be required to establish a program for meeting certain minimum goals each year. Unless some such steps are taken many of the village banks may be tempted to continue to rely solely on district banks without building up their local organization.

The suggestion of the Committee that provisions be worked out for repayment of loans in kind wherever possible should also be followed. Such practices are familiar to cultivators who are accustomed to repayment of sabape loans in kind. Some cooperatives are already collecting in kind and report good results not only in repayment of loans but in better prices.

In addition to flat per-acre loans, cultivators should be allowed to obtain on credit improved seed, fertilizer, implements, machines and other supplies distributed by the Agriculture Department. It should be relatively easy to devise procedures for consolidating these loans with the per-acre loans for purposes of collection. This would assist the Department in obtaining more widespread use of improved methods. The increased output which can be expected from use of better methods should enable the cultivator to assume the added loan.

The following measures to meet the problem of short-term credit are therefore recommended:

(1) An intensive information program to educate farmers in the proper use of credit.

(2) Building up responsibility at the village level by insisting on adherence to certain minimum financial standards including contributions to share capital.

(3) Continuation of the program gradually to establish district branches of the State Agricultural Bank in all districts.

(4) Encouraging repayment of loans in kind wherever possible.

(5) Establishment of procedures to enable the Agriculture Department to issue improved seed, fertilizer, implements, etc., on credit in conjunction with the system of state agricultural credit, and the farm extension and demonstration services.

b. Intermediate and Long-term Credit Requirements

The principal need for loans of more than one year (intermediate term) at present is for the purchase of cattle. Other requirements are for small land development projects, and for equipment and improvements of all kinds. An increasing amount of the land improvement work can be handled through Pyidawtha grants. There are very few types of farm equipment in current use which cannot be paid out of the proceeds from one year's production.

A yoke of oxen costs from about K400 to about K500. The average working life is about five years. Under normal conditions a cultivator can repay such a loan over a period of three or four years. Death of cattle is probably the chief cause of unavoidable indebtedness among farmers. Suggestions for taking care of this problem have varied from government cattle insurance and voluntary savings plans to direct government loans. Measures for reducing cattle diseases and prolonging the working life of the animals are also important in reducing the size of the financing problem. The greatest improvement can be expected to arise from the development, demonstration, and training which will be provided by the demonstration farms and extension services.

Government loans for cattle purchases in the past have been wholly inadequate in amount and the complicated red tape involved has prevented cultivators from making much use of such loans.

Security for the loans had to be more substantial than for seasonal crop loans since the amounts involved were greater and there was no guarantee that the borrower would continue to cultivate land. With more stable tenure conditions today, there appears to be less risk than before in that crop liens can be taken in addition to the security provided by the cattle. Binns, in his "Agricultural Economy in Burma," suggests a plan for repayment of cattle loans in equal installments secured by crop mortgages. District branches of the State Agricultural Bank might advantageously start insurance of cattle loans on this basis in a few selected areas to determine whether such a plan is workable.

Voluntary cattle-replacement savings programs have been started on a small scale by some of the agricultural cooperatives to encourage farmers to finance cattle purchase partially from their own savings, but generally there are no facilities for such savings. As soon as village banks become well established, consideration should be given to expanding their functions to receive savings deposits as well as to make loans.

Cattle insurance offers probably the best solution in the long run since it would spread the cost of cattle replacement over the average working life of the animal and would protect cultivators against unexpected losses through epidemics. However, before instituting any system of cattle insurance a thorough study should be made. Accurate statistics on number and causes of deaths by district will be needed to determine risk and premium rates. The question of the basis for participation will have to be decided. Compulsory participation may be required in order to avoid problems of adverse selectivity, i.e., greater participation in high risk areas with consequent higher premium rates. On the other hand in view of the Government's policy of keeping down the price of paddy, it may be desirable to keep insurance on a voluntary basis with partial government subsidization of premium charges.

With land nationalization, the need for funds to purchase land, which elsewhere is the principal need for really long-term credit in agriculture, will be eliminated. At the same time the principal security for long-term agricultural loans and mortgages on land will also be eliminated. Other requirements for long-term loans have been consolidation of accumulated shorter-term borrowings, sickness, ceremonies and "failure of agricultural income." Improvements in short-term financing will do much to take care of the problem of debt consolidation and "failure of agricultural income" since heavy interest charges were probably the principal cause of accumulated indebtedness. The problem of long-term credit is not therefore now a pressing one.

4. AGRICULTURAL TAXATION

The land revenue tax is the principal direct tax on agriculture. It has declined in relative importance as a revenue measure from 1938–39, the immediate prewar year, when it accounted for more than one quarter of total tax revenues until it now provides less than 5% of tax revenues. This drop is attributable to the facts that land revenue rates have not been adjusted upward with the general increase in price level and that land revenue is now being collected from only about half of the prewar area.

Persons engaged in other occupations pay no direct taxes unless incomes are in excess of K2,000. Most farmers have incomes of less than K2,000 per year but pay land revenue either directly or indirectly. Hence, in terms of ability to pay, farmers bear a higher proportion of direct taxes than non-farmers. In addition, the internal price control on paddy can be considered to be a form of indirect taxation which the farmer is bearing. Though the unbalance is minor, it is a form of discrimination which is not in keeping with the principles of democratic government.

The land revenue tax is a fixed tax per acre based on the theoretical net return from the land. In prewar days these rates were determined on the basis of detailed land settlement surveys conducted about every 20 years in each district. Rates of assessment varied considerably from district to district since settlements were not carried out simultaneously and the rate varied with the level of prices and the need for revenue at the time of the settlement. Although effort was made to keep rates somewhat consistent with neighboring districts there was no systematic effort toward uniformity of assessments for all Burma.

Present land revenue rates are based on settlement surveys extending from 1913 to 1940. During this time the price of rice varied from a low of K52 per 100 baskets to K262 per 100 baskets as compared to the present price of K300 per 100 baskets in Rangoon. As a result land revenue rates no longer reflect differences in actual net returns from the land. So long as the rates are at present levels this inequity in distribution of tax burden is not serious. When land is distributed under the land nationalization program it will be possible to adjust revenue rates to correct major discrepancies without carrying through a complete new series of settlement surveys.

The land revenue tax with its infrequent rate adjustments is very inelastic in its revenue yields. Before the war this resulted in heavy burdens on the farmer during periods of low prices and provided Government with inadequate revenues in periods of high prices. Tax revenues which fall or rise faster than prices are fiscally desirable. However, as long as land revenue rates are low and land revenue is a minor source of tax revenue it will not create any serious pressures for the farmer or interfere with the Government's fiscal policy. Land revenues should be increased only when persons in income brackets comparable to that of the cultivator are also subject to direct taxes.

The complex method of establishing land revenue through land settlement operations has been quite costly in terms of the revenues derived from the tax. Prewar the costs of administration amounted to about 10% of land revenue. Postwar the percentage has ranged from 59 to 174. With less emphasis on the land-revenue tax the complicated settlement operations of the past will no longer be necessary. Once initial adjustments are made at the time of land nationalization, rates need not be changed except as major changes in land use or land productivity occur or as discrepancies are reported.

The job of maintaining land records should be taken over by the agency managing state-owned lands under the land nationalization program. The records should be primarily for the purpose of distributing tenancies and maintaining title records on owner-cultivator land.

Collection of crop statistics should be separated from the tax collection function and established under an independent agency. Statistics collected for tax purposes usually show a downward bias since the farmer is anxious to conceal production in order to pay lower taxes. For crop estimating purposes it is not necessary to have detailed data at the Kwin level. With modern statistical sampling methods it will be possible to get accurate estimates of crop production with a relatively small staff and at relatively low cost.

As functions of local government are expanded under the Pyidawtha plan consideration should be given to making the land-revenue tax a source of local government revenue.

5. MARKETING THE CROP

a. Farmers' Handicaps

The position of the farmer as a small producer engaged primarily in the production of crops and only intermittently concerned with selling his product places him at a disadvantage in his dealings with traders who are engaged full time in buying and selling. This has led in other countries to government efforts to assist farmers in getting better prices for their crops. These include formation of farmers' cooperatives, standardization of grades, adoption of uniform weights and measures, provisions for furnishing market information to farmers and price stabilization policies.

Studies made by the prewar Marketing Section of the Department of Agriculture disclosed that the cultivator was not getting the full share of the price of his products in the central market because of his poor bargaining position, the lack of organized local markets, and the lack of uniform standards of weights, measures and grades. Even in the case of paddy where the market mechanism is most developed, the discrepancies in prices paid in different markets were in excess of the freight and handling charges involved in linking various markets. For other crops there were much greater discrepancies, and for many crops there was no semblance of organized marketing, even on a local scale.

The postwar situation is similar. Activities of the SAMB and cooperative organizations have improved marketing practices to some extent in areas where they are operating. However, disruption of communication and transportation and the general insecurity in rural areas have made marketing conditions worse than before the war in many parts of the country. Much of the crop is still transferred to shopkeepers, money-lenders, brokers and landlords at the threshing-floor in settlement of existing debts. Farmers sell the remainder of their crop to jungle brokers or in some instances to cooperatives which take the produce from the village to primary assembly points, whence it is shipped by boat or rail to the mills in Rangoon and other port cities.

b. Marketing Standards

The system of grading is very rough. Different qualities are often mixed together at the primary assembly stage. Even in lower Burma where paddy is an export crop, consignments of pure varieties can only be obtained from special areas devoted to particular types. Most paddy is purchased as fair average quality of a certain type, and buyers often make weight adjustments for inferior paddy but not for better grades. These adjustments are often arbitrary, and the cultivator is tempted to adulterate his products as much as possible. This of course leads to further weight cuts on the part of the buyer. These factors add to the cost of marketing by necessitating more rigid inspection at each level. They also force buyers to try to protect themselves against adulteration by paying as low a price as possible. The cultivator, who is in a poor bargaining position, generally has no recourse, even if the quality reduction is unfair, and he receives a low price.

There are no uniform standards of weights and measures. The standard basket of paddy has a capacity of 9 gallons and a standard weight of 46 pounds. Variations from this standard are the rule for almost all transactions outside Rangoon. The standard basket for groundnuts which is 25 pounds in Rangoon ranges as high as 44 pounds in some districts. Buyers, particularly at the primary collection centers, tend to use large-size baskets or faulty scales. A check of 154 beam balances by the Marketing Section of the Agricultural Department in 1940 showed that farmers were being short-weighed from 3% to 11%. Even where standard-sized baskets are used, the method of measuring can result in more or less paddy per basket. This lack of standards tends to make the operation of normal market forces weak, and transactions tend to become personal.

Paddy, groundnuts, sesamum, some of the pulses, cotton and sugar can have relatively well-developed markets in the producing centers, but these are not effectively linked with central markets as a result of the differences in standards. Other crops are generally sold by the farmer in small quantities to brokers at the village or at local bazaars which are held about once every five days. Local merchants and itinerant traders gather at these bazaars to purchase farm products. The lack of standard qualities and the use of inaccurate weights and measures are even more pronounced for these other crops, and the markets more poorly organized. The higher trading risks which result are usually borne by the farmer in lower prices for his crops.

Uniform standards of weights, measures and grades will provide the basis for more accurate price quotations, facilitate trading between distant markets, and enable the farmer to get the full market price for his crops. The prewar Marketing Section of the Department of Agriculture started some very useful work toward standardization in distributing standard baskets, inspecting weights and measures and establishing regulated markets. The work has been discontinued since the war, however, and steps should be taken to reinstitute this work. The local Pyidawtha committees and agricultural cooperatives can serve a very useful function in assisting the Government in carrying through such a program. However, as the establishment and maintenance of proper standards of weights and measures affect the entire productive and scientific economy, and as they require scientific laboratory and research facilities, it is recommended that responsibility for the broad development, testing, and regulation of standards be legislatively assigned to a central scientific organization, with enforcement vested in various interested agencies such as the Ministry of Agriculture and the Ministry of Industry.

Another consequence of the present marketing situation is that differences in prices between different markets or even within the same local market are often greater than for different crops. At present, local traders and brokers keep in touch with other markets and know by experience the prices they can afford to pay to the farmer in relation to prevailing prices in other markets. The farmer is, however, ignorant of conditions outside his village. For this reason, substantial changes in prices are necessary to effect changes in production. As market standards improve, prices in different markets will become more uniform, and differences in prices between crops will assume increasing importance as a factor in determining which crops are to be planted.

For the future, the Government should consider the establishment of a market outlook service to provide farmers with accurate information on current and expected prices, timely forecasts of crop acreage and yield, and implications of these trends on the farmer's production plans. The prewar Marketing Section started some basic work in its surveys which dealt primarily with current and past trends and descriptions of the marketing mechanism. This work should be resumed and eventually, as competent personnel become available, increasing emphasis should be placed on outlook analysis. The Department of Agriculture even now collects prices of principal agricultural crops from various district headquarters. These could be used to prepare periodic bulletins to extension workers. This information, as well as the results of any marketing studies which may be undertaken, should be widely disseminated to farmers through the extension and information services. Market information will be useful to the farmer not only in getting the full market value for his crops but also in planting crops which will bring him the best returns.

c. Price Policy

In a normal free marketing situation, production is responsive to prices. Where it controls prices the Government can fix them at levels consistent with economic objectives, but effectiveness is limited by ability to control the market. The Government has been able to carry out its paddy price policy because it buys and sells sufficient quantities of paddy and rice to dominate the market. Where the Government purchases do not dominate the market, price policy cannot be enforced effectively without resorting to direct distribution controls.

Pricing programs should therefore be limited to those crops for which the Government is prepared to enter the market. For certain new crops which the Government is trying to establish it may be desirable to offer incentive prices above the market. For example, the production of long stapled cotton is at present very limited, and the Government could afford to purchase total production at a premium in order to persuade more farmers to substitute the improved varieties for the short stapled cotton which they are now growing. Likewise the Government could pay a premium for jute. The premium prices should not be allowed to become a permanent subsidy program but rather a temporary program to get enough production to judge whether the crops can be economically grown.

d. Cooperatives

Farm cooperatives can play a significant role in improving the marketing of agricultural crops. Through cooperative effort farmers who individually have a poor basis for credit can collectively obtain loans. Many of the functions now performed by the middleman and others can be taken over by farmers' cooperatives. For example, where it would not pay an individual farmer to take his own produce to the primary assembling point a number of farmers joined together in a cooperative could hire a boat to take the produce to the market. Cooperatives can keep in closer touch with various markets; can build cooperative facilities for storage, threshing and simple processing; and, by dealing in larger quantities, can insist on adherence to standards of grades, weights and measures.

Multi-purpose cooperatives are fairly complex business organizations requiring skilled management for successful operation. The postwar experience of many Japanese cooperatives indicates that the fewer the functions of a cooperative the greater the likelihood of success. Too ambitious a program in the initial phases tends to overburden the management and results in inefficiency. Cooperatives can serve a useful function by providing a channel for government loans, for farmer savings, and group purchase of essential production supplies as well as for marketing of crops. As the cooperative grows and its financial position improves, steps can be taken to add new functions as demanded by the membership.

Cooperative storage facilities can add to the income of farmers by enabling them to hold stocks in periods of low prices for sale later at higher prices. With proper storage facilities the State Agricultural Bank or other credit institutions could extend credit on the security of the stored crop and relieve farmers of the necessity for immediate sales. Bulk handling and storage also will permit larger-scale sales direct to processors. Joint storage would reduce storage losses since better buildings and conservation methods could be used.

Establishment of cooperative processing facilities at the village level would permit more efficient processing of crops now processed by individual farmers using primitive methods, increase or stabilize income from crops which require nearby processing facilities, and create seasonal employment opportunities. For example, small oil expellers have about 40 times the capacity of a single Hsizon (bullock-powered crusher), and extract a much higher percentage of the oil. Small sugar factories requiring relatively little investment can greatly increase the income from sugar cane as compared to the primitive methods of making kyanthagar. Small cooperative flue curing barns have substantially increased returns from Virginia tobacco to growers in the Mandalay area. Cooperative ginning of cotton and milling of rice are other possibilities.

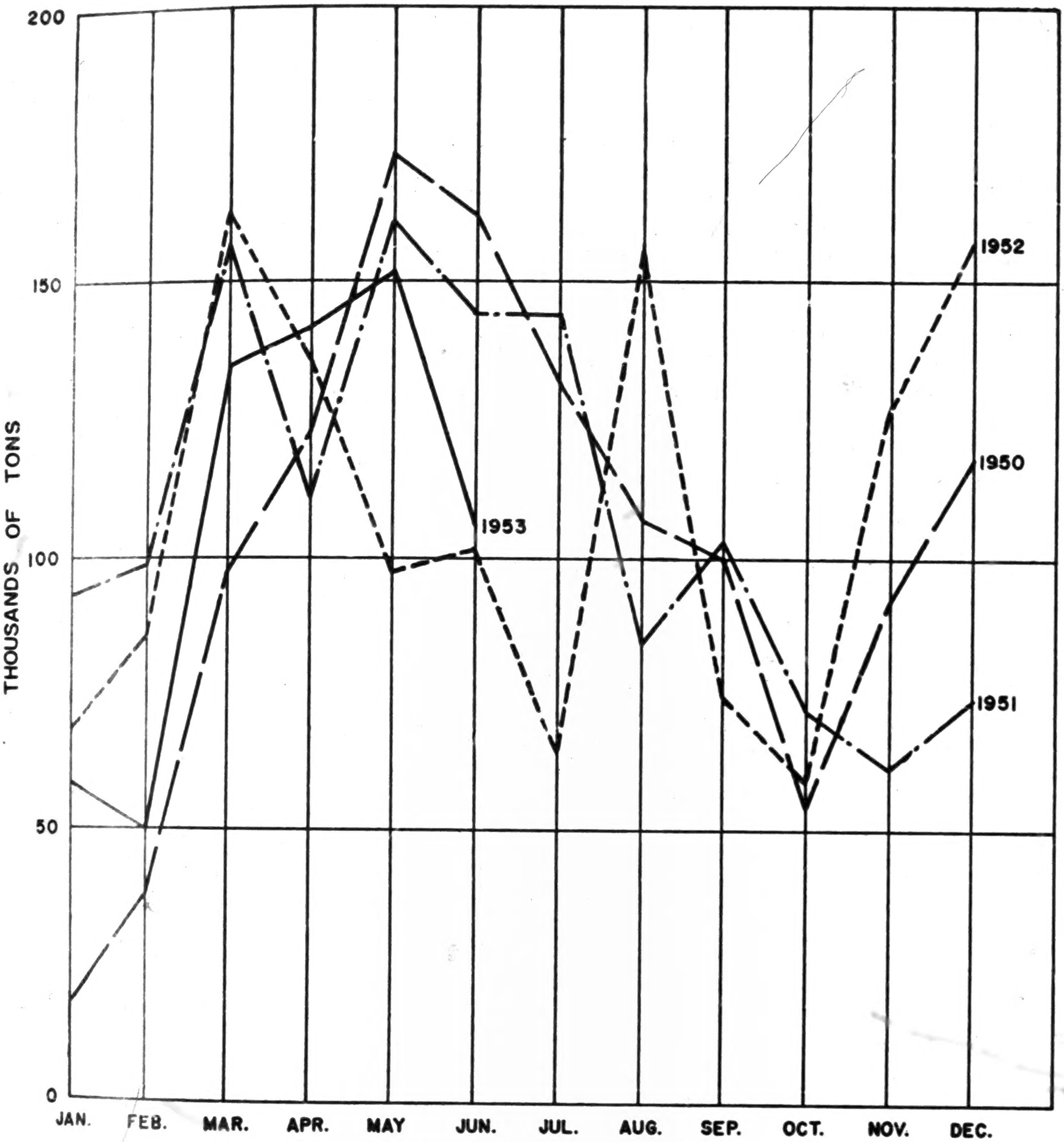
Many cooperatives have already been established in Burma. The total in 1952 was over 12,000. That their success has been limited is attributed to lack of technical and management skills and to lack of coordinated effort to develop the needed skills and understanding.

The problem of establishing independent cooperatives is largely one of mass education of farmers in these matters. Sound cooperatives cannot be established through fiat. The basic groundwork must be there, and work must be started immediately to provide it. An expanded agricultural education and information program should be carried through to provide the means for a determined effort to educate the farmers in the principles of cooperatives.

6. THE STATE AGRICULTURAL MARKETING BOARD

The State Agricultural Marketing Board was established in 1946 as a public monopoly to control all exports of rice. The original purpose was to eliminate the monopolistic position which large foreign-owned mills held in the prewar rice export market, and to keep rice export profits within Burma. The subsequent rise in the world price of rice together with the policy of holding domestic paddy prices constant has since made the SAMB the principal source of government revenues. Although cultivators have not received direct benefits from the favorable export prices of rice, they have been guaranteed a minimum price for paddy. The profits from rice exports permit the Government to make current and capital expenditures which will increase incomes and living standards and provide the people with services which would otherwise not be available.

The Government makes export allocations by country of destination. About two thirds of each government's allocation has been sold directly to the buying government by the State Agricultural Marketing Board. For the remaining third, SAMB has received tenders from private domestic concerns for rice for export to specific countries. The domestic concern usually operates as an agent for a foreign importing concern or for the foreign government itself.



MONTHLY RICE EXPORTS

MINISTRY OF NATIONAL PLANNING

MONTHLY
RICE EXPORTS

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY CK. BY	DATE JULY 53	PLATE NO. 5

Government-to-government prices were £50 per ton during the first half of 1952 and £55 during the last half, and have been £60 so far in 1953. Quantities offered for private tender during the autumn and winter of 1952 were accepted at prices running as high as £85 per ton for Small Mills Special. Prices offered in 1953 are markedly lower. During January–May, the Government had invited private tenders on about 275,000 tons but had accepted the tenders on only about one third of this amount. The prices paid, however, were still well above the government-to-government price, and £10 to £15 above the prices during the same period last year.

Price prospects are of great importance to the Government.

Increases in world rice production since before the war have been much less than increased needs resulting from population increases in rice-consuming areas, and are not likely to overtake them in the foreseeable future, according to studies by the Food Agricultural Organization of the United Nations and by the United States Department of Agriculture. Increases in productivity in rice production in Asia can bring great increases in output, but they will come only very gradually, and are likely to be offset by increased consumption of rice. It is safe to assume that during the remainder of this decade export prices for Burma's rice will remain well above their prewar relationship to prices of Burma's imports. However, a level or falling price trend seems more probable than a return to 1952 peaks, and price and marketing policies of the State Agricultural Marketing Board should be adjusted—and indeed have already been adjusted—to this expectation.

During the period of sharply rising prices in 1951 and 1952, the Government followed a policy of holding off export allocations. (Plate 5 shows the monthly pattern of shipments during the period 1950–53.) The motivation was not necessarily anticipation of rising prices; in part at least it was required because of the uncertainty of supplies of rice. In any case, the policy resulted in maximizing foreign exchange earnings. However, now that the period of rapidly increasing export prices has ended, and the probability seems strong of no further rise (except possibly temporarily as the result of an unusually short world rice crop), SAMB should sell rice more expeditiously in order to maximize sales at current favorable prices and hold existing markets.

Earlier shipment would relieve the problem of rice storage at port cities, which is especially acute this year. However, earlier sale need not mean return to the seasonal shipping peak which was typical before the war. The prewar pattern of concentrating rice shipments in the months before the monsoons required port facilities which remained idle during the rest of the year. As also recommended in Chapter XII, storage facilities secure against insects, rodents and other spoilage should be constructed and bulk handling facilities installed so that the Government will be able to store sufficient rice to spread its shipments over a longer period and to take advantage of short-term fluctuations in the rice market. While there was no reason for private shippers before the war to adjust their shipping dates to lessen peak port requirements, it is advantageous for the Government to do so. The need for improved storage facilities if this policy is to be followed must be emphasized. Otherwise, quality deterioration in storage could cause an increasingly serious sales problem in future years.

It is recommended that the Government explore the possibility of arranging for trade agreements for the sale of rice. These agreements, if they are to be advantageous, should extend over a relatively long period. Such agreements would specify minimum amounts which would be exported by Burma at an agreed price (if world prices should rise above this level) and minimum amounts which the importing country would accept at an agreed price (if world prices fall below this level).

Continued effort should be made to improve the quality of Burma rice. With improved availabilities of rice Burma will have more and more difficulty in disposing of poor-quality rice. Measures for encouraging use of improved seed and for establishing uniform standards of grading should be adopted. Improvements in rice milling and storage facilities are also important.

7. GOVERNMENT ORGANIZATION FOR AGRICULTURE

a. The Ministries

At present, governmental functions relating to agriculture are performed by four different ministries (see Plate 6). The Ministry of Land Nationalization and that of Agriculture and Forests are the two principal ones involved. The Ministry of Land Nationalization was created in 1952 to bring together functions which relate to the Land Nationalization Program in an effort to expedite implementation of the Government's policies. Its functions include, in addition to planning and execution of the land nationalization program, establishment and supervision of State colonies, surveys (topographical, cadastral, map printing and mine surveys), "settlement" (determination of land-revenue tax rates) and land records and crop reporting.

The Ministry of Agriculture and Forests is responsible for agricultural extension and research, veterinary affairs, State credit, irrigation, tenancy

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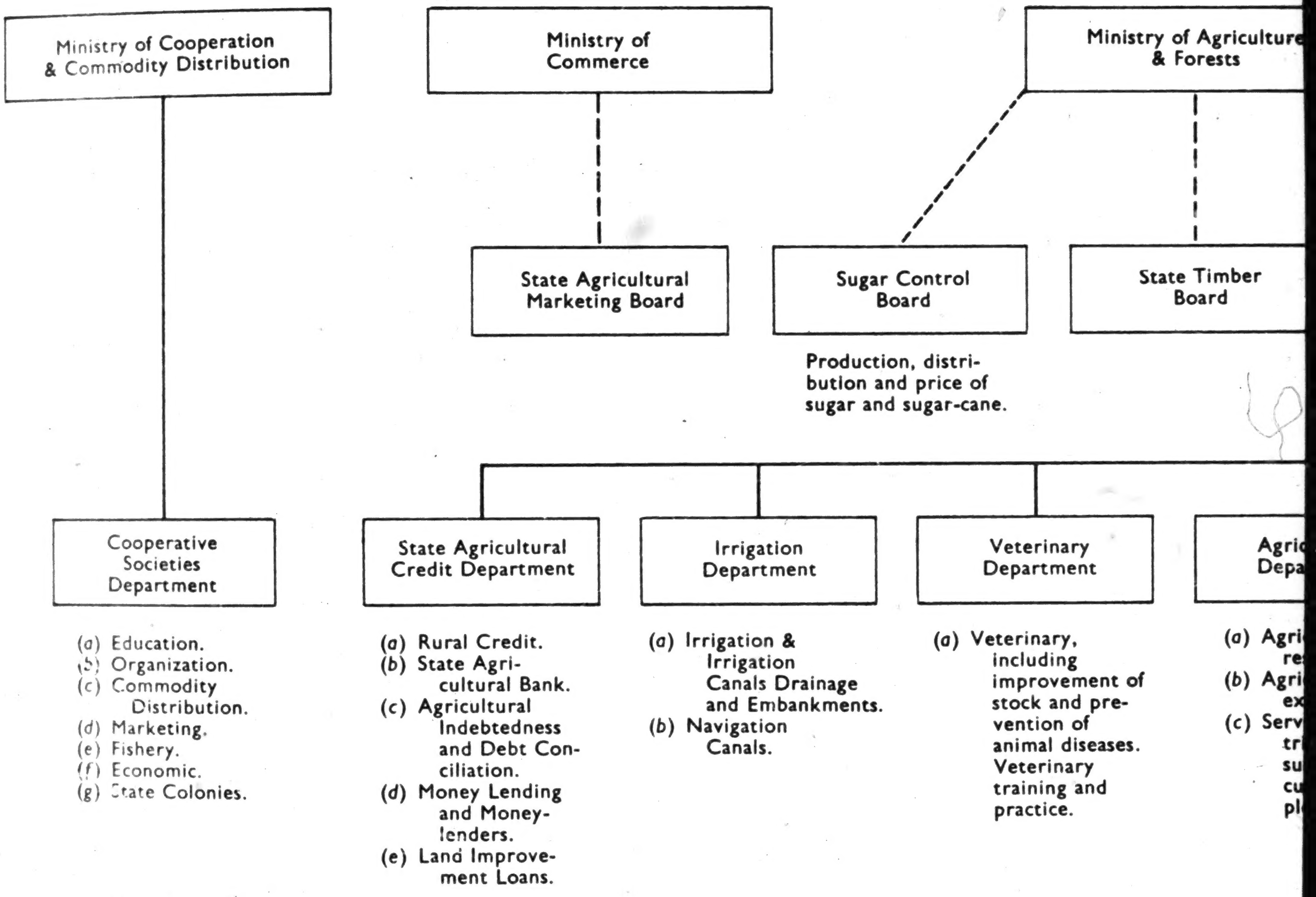

Ministry of Cooperation & Commodity Distribution

Ministry of Commerce

Ministry of Agriculture & Forests

State Agricultural Marketing Board

Sugar Control Board

Production, distribution and price of sugar and sugar-cane.

State Timber Board

Cooperative Societies Department

(a) Education.
(b) Organization.
(c) Commodity Distribution.
(d) Marketing.
(e) Fishery.
(f) Economic.
(g) State Colonies.

State Agricultural Credit Department

(a) Rural Credit.
(b) State Agricultural Bank.
(c) Agricultural Indebtedness and Debt Conciliation.
(d) Money Lending and Money-lenders.
(e) Land Improvement Loans.

Irrigation Department

(a) Irrigation & Irrigation Canals Drainage and Embankments.
(b) Navigation Canals.

Veterinary Department

(a) Veterinary, including improvement of stock and prevention of animal diseases. Veterinary training and practice.

Agri Depa

(a) Agri re
(b) Agri ex
(c) Serv tr su cu pl

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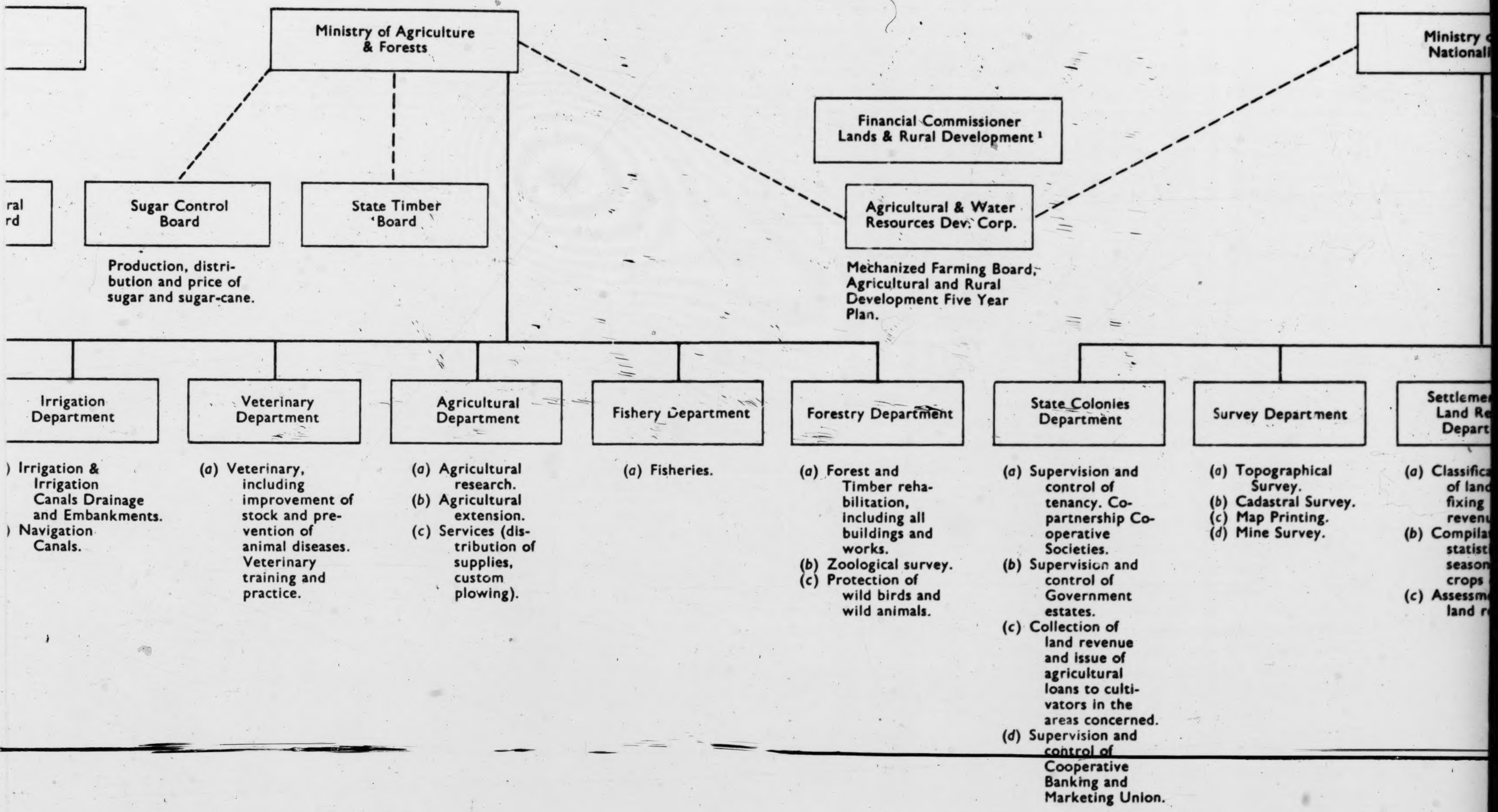
[1] The Financial Commissioner (Lands & Rural Development) is responsible for all fiscal and financial matters relating to land and

PLATE NO. 6

GOVERNMENT AGENCIES CONCERNED WITH AGRICULTURE


Ministry of Agriculture & Forests
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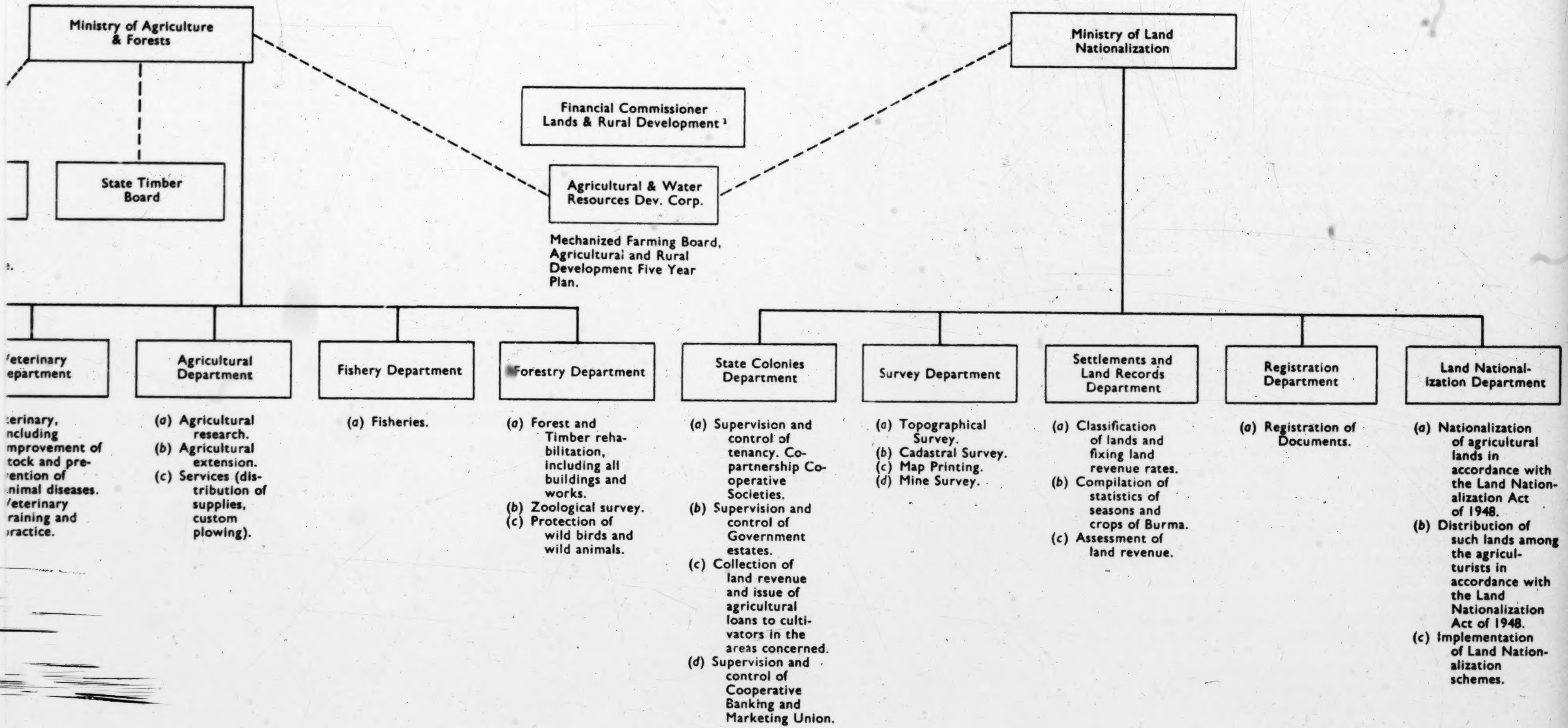
rd
Sugar Control Board
Production, distribution and price of sugar and sugar-cane.
State Timber Board
Financial Commissioner Lands & Rural Development ¹
Agricultural & Water Resources Dev. Corp.
Mechanized Farming Board, Agricultural and Rural Development Five Year Plan.
Ministry
Nationali
Irrigation Department
) Irrigation & Irrigation Canals Drainage and Embankments.
) Navigation Canals.
Veterinary Department
(a) Veterinary, including improvement of stock and prevention of animal diseases. Veterinary training and practice.
Agricultural Department
(a) Agricultural research.
(b) Agricultural extension.
(c) Services (distribution of supplies, custom plowing).
Fishery Department
(a) Fisheries.
Forestry Department
(a) Forest and Timber rehabilitation, including all buildings and works.
(b) Zoological survey.
(c) Protection of wild birds and wild animals.
State Colonies Department
(a) Supervision and control of tenancy. Co-partnership Co-operative Societies.
(b) Supervision and control of Government estates.
(c) Collection of land revenue and issue of agricultural loans to cultivators in the areas concerned.
(d) Supervision and control of Cooperative Banking and Marketing Union.
Survey Department
(a) Topographical Survey.
(b) Cadastral Survey.
(c) Map Printing.
(d) Mine Survey.
Settleme
Land Re
Depart
(a) Classifica of lan fixing revenu
(b) Compila statist season crops
(c) Assessm land r

esponsible for all fiscal and financial matters relating to land and rural development. Department heads report to him on matters relating to taxes.

PLATE NO. 6

GOVERNMENT AGENCIES CONCERNED WITH AGRICULTURE


Ministry of Agriculture & Forests
Ministry of Land Nationalization
Financial Commissioner Lands & Rural Development [1]
State Timber Board
Agricultural & Water Resources Dev. Corp.
Mechanized Farming Board, Agricultural and Rural Development Five Year Plan.
e.
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erinary, ncluding mprovement of tock and pre- ention of nimal diseases. eterinary raining and ractice.
Agricultural Department
(a) Agricultural research.
(b) Agricultural extension.
(c) Services (distribution of supplies, custom plowing).
Fishery Department
(a) Fisheries.
Forestry Department
(a) Forest and Timber rehabilitation, including all buildings and works.
(b) Zoological survey.
(c) Protection of wild birds and wild animals.
State Colonies Department
(a) Supervision and control of tenancy. Co-partnership Cooperative Societies.
(b) Supervision and control of Government estates.
(c) Collection of land revenue and issue of agricultural loans to cultivators in the areas concerned.
(d) Supervision and control of Cooperative Banking and Marketing Union.
Survey Department
(a) Topographical Survey.
(b) Cadastral Survey.
(c) Map Printing.
(d) Mine Survey.
Settlements and Land Records Department
(a) Classification of lands and fixing land revenue rates.
(b) Compilation of statistics of seasons and crops of Burma.
(c) Assessment of land revenue.
Registration Department
(a) Registration of Documents.
Land Nationalization Department
(a) Nationalization of agricultural lands in accordance with the Land Nationalization Act of 1948.
(b) Distribution of such lands among the agriculturists in accordance with the Land Nationalization Act of 1948.
(c) Implementation of Land Nationalization schemes.

ial matters relating to land and rural development. Department heads report to him on matters relating to taxes.

controls, farm labor, and fisheries and forests. The Cooperative Societies Department of the Ministry of Cooperation and Commodity Distribution is responsible for registration, audit and development of cooperatives, rural as well as urban. The Financial Commissioner (Land and Rural Development), who has a number of responsibilities relating to government revenues from agriculture, usually acts with the approval of the Ministry of Agriculture and Forests. The recently established Agriculture and Water Resources Development Corporation, which is responsible for planning and financing of agricultural projects under the Pyidawtha Plan, is under a Board of Directors including representatives of all of the principal agricultural agencies. The State Agricultural Marketing Board is an autonomous board which is under the Ministry of Commerce.

Below the cabinet level, coordination of the policies of these agencies depends primarily on the initiative and imagination of persons in responsible positions. While a number of inter-ministerial boards and committees exist, they meet infrequently and have no permanent staff to provide continuing attention to the problems of coordination. Furthermore the individual members of these bodies are typically overburdened with responsibilities relating to their own programs and are members of so many committees that they cannot devote the time or the energy required for effective integration. Consequently there is substantial duplication and overlapping of functions. For example, farm cooperatives are being planned separately in two ministries, as are means for increasing the use of machinery in agriculture. Field staffs are now maintained separately by the Agriculture Department, the Irrigation Department, the Ministry of Land Nationalization, the Commissioner of Settlements and Land Records, the Cooperative Department, and the State Agricultural Marketing Board.

There is also failure to achieve a consistent coherent program for meeting over-all goals. Integrated planning in agriculture will make it possible to schedule specific measures to achieve over-all goals and maximum benefits. Individual measures carried out in isolation seldom yield as much benefit as an integrated program in which various measures reinforce and sustain each other. Provision of farm credit on reasonable terms will increase production but will be even more effective if accompanied by technical advice on improved methods. Benefits from tenancy reforms will similarly be less likely to be dissipated if credit on reasonable terms is available and farmers are taught proper methods.

In order to achieve proper integration of agricultural policies it is recommended that the principal agricultural functions be brought together under one Ministry. In bringing them together, it will be desirable to reallocate functions in order to eliminate duplication and overlapping in so far as it is possible. It should also be possible to consolidate field staffs to some extent and to reduce overhead costs involved in maintaining separate establishments. A tentative plan for reorganization of agricultural agencies is presented in the succeeding paragraphs (see Plate 7).

b. Minister's Staff

The staff of the Secretariat of the Ministry should be greatly strengthened to provide a small group of experienced agriculturists of administrative caliber to plan and expedite an integrated program. The Secretary should be assisted by a joint secretary for planning, who would head up the planning staff and the Agriculture and Water Resources Development Corporation. The Ministry would also have deputy secretaries for administration, land nationalization, and Pyidawtha, and assistant secretaries for information, forestry and fisheries who will work with the planning staff on problems relating to their respective fields (see Plate 8).

The planning staff would keep in close touch with the progress of all agricultural programs and advise the Minister on the formulation and execution of broad agricultural policies. It would see that the various measures are consistent with over-all policies and would assist the minister in allocating responsibilities to specific agencies. It would be expected to provide a continuing appraisal of the programs in the light of changing conditions. It would play a key role in determining priorities in the formulation of the budget.

The planning unit would also coordinate the work of the departments so that they keep to the planning body's program. It will take projects from various departments and boards and fit them together into a consistent and well-balanced program. There must be close cooperation between this small unit of very capable personnel and the entire ministry.

c. Agricultural Information Service

The officer-in-charge of information should have a technical knowledge of agriculture. A flair for writing and enthusiasm for development should also be major assets. The most suitable person would, of course, be one who is in the agricultural service with experience in journalism. Such talent is available in the department. Timely information is important, accessibility to documents and direct relationship with all departments is also desirable. This officer should be an assistant secretary and his unit should therefore be in the secretary's office. Funds should be

PLATE NO. 7

PROPOSED GOVERNMENT AGENCIES CONCERNED WITH AGRICULTURE

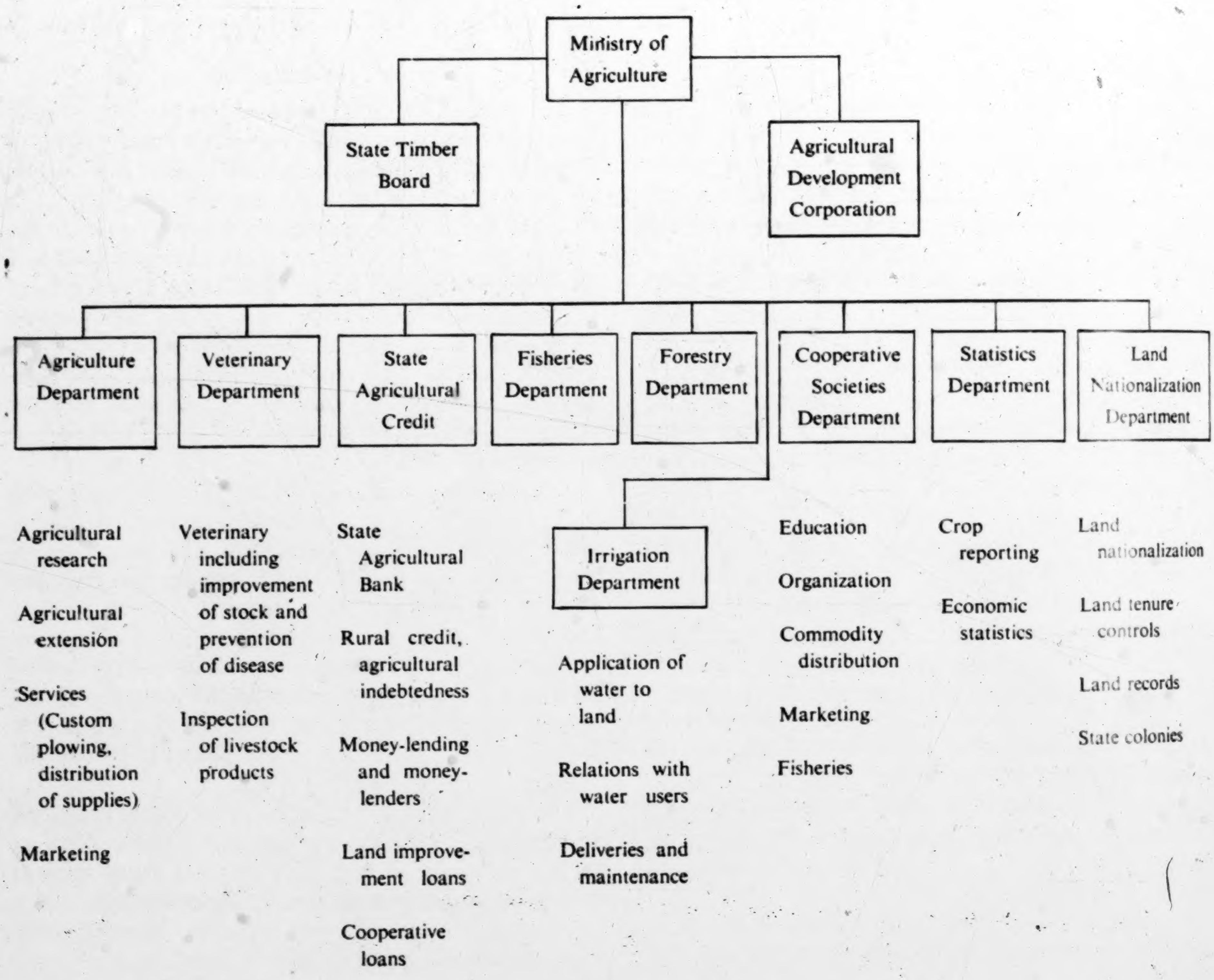
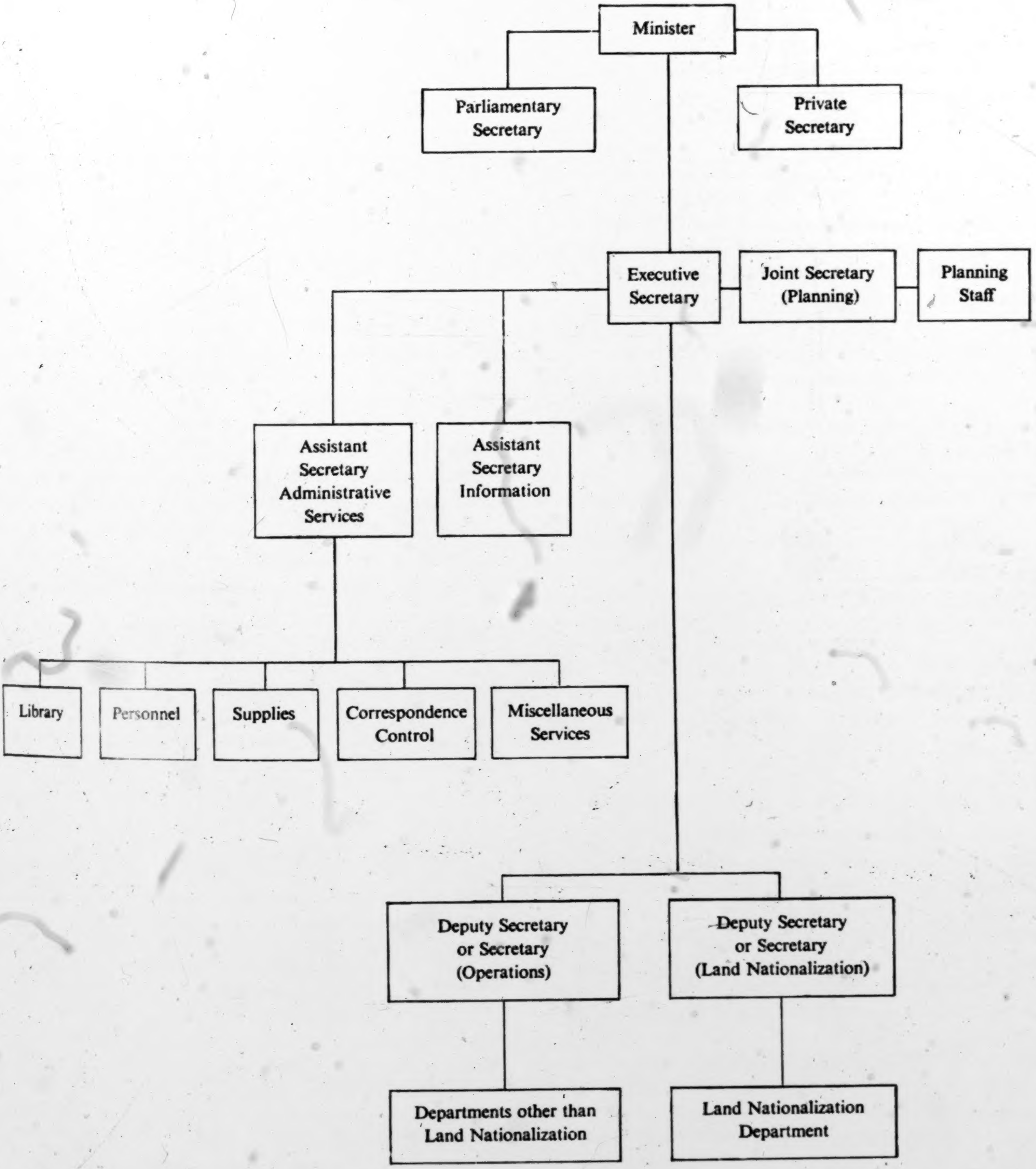

Ministry of Agriculture
State Timber Board
Agricultural Development Corporation
Agriculture Department
Veterinary Department
State Agricultural Credit
Fisheries Department
Forestry Department
Cooperative Societies Department
Statistics Department
Land Nationalization Department
Irrigation Department
Agricultural research
Agricultural extension
Services (Custom plowing, distribution of supplies)
Marketing
Veterinary including improvement of stock and prevention of disease
Inspection of livestock products
State Agricultural Bank
Rural credit, agricultural indebtedness
Money-lending and money-lenders
Land improvement loans
Cooperative loans
Application of water to land
Relations with water users
Deliveries and maintenance
Education
Organization
Commodity distribution
Marketing
Fisheries
Crop reporting
Economic statistics
Land nationalization
Land tenure controls
Land records
State colonies

PLATE NO. 8

PROPOSED ORGANIZATION OF SECRETARIAT OF MINISTRY OF AGRICULTURE


Minister
Parliamentary Secretary
Private Secretary
Executive Secretary
Joint Secretary (Planning)
Planning Staff
Assistant Secretary Administrative Services
Assistant Secretary Information
Library
Personnel
Supplies
Correspondence Control
Miscellaneous Services
Deputy Secretary or Secretary (Operations)
Deputy Secretary or Secretary (Land Nationalization)
Departments other than Land Nationalization
Land Nationalization Department

allocated to the preparation of information and technical bulletins, to the publication of a popular periodical, and to the preparation of occasional special exhibits and exhibiting equipment.

Acceptance of and participation in the program by the farmers is of utmost importance if the Ministry's program is to be successful. Automatic response and concerted effort cannot be expected from the multitude of farmers. Hence information on the various aspects of the program must constantly reach the farmers. This information should stress things of interest to the farmer. The language must be simple and pictures must make the simple obvious. Useful pamphlets are published by the Department of Agriculture. They should be revised, brought up to date technically, and put into language understandable to the farmer. In addition, simple explanations of the regulations on land tenure, the land nationalization program, the government loan program, marketing information, as well as every other facet of the agricultural development program, should be widely disseminated. A farm magazine should also be published. Initially it should be issued whenever enough material has been gathered. The printed material is only one of the means of educating the farmer. Audio-visual aids should be used wherever possible.

d. Library

Another unit needed is a central ministerial library with a qualified librarian. Most departments have libraries of their own and there is the secretariat library, but access to these is difficult and books are not properly catalogued. A central library for agriculture with a qualified librarian can keep the ministry staff informed on new additions to the library and provide a central location for keeping agricultural publications.

e. New Department for Land Nationalization

Land nationalization is of such basic importance that a separate department should be established in the new ministry and a post of deputy secretary for land nationalization should be established at the secretariat level. All of the present agencies under the present Land Nationalization Ministry should be transferred to this new department with the exception of the crop-reporting function of Commissioner of Settlement and Land Records, which should be under the proposed Statistics Department, and other functions which are now being performed by other existing agencies. In addition it should take over responsibilities for enforcement of rent controls and tenancy disposal which are now under the Ministry of Agriculture and Forests.

f. Expansion of Agriculture Department

The Agriculture Department should be greatly expanded along the lines discussed later in this chapter in the section on extension and research. The Department should also assume responsibilities in relation to the mechanization proposals such as establishment of the machine and tractor equipment pools and state farms which now form part of the ten-year plan for land nationalization. It should also supervise the establishment of model demonstration farms with a view toward integrating all of these proposals into the system of central farms, district farms, and major and minor seed farms for which the Department is now responsible. In addition the Department should re-establish the prewar Marketing Section to carry on work on standardization of grades, weights and measures.

g. Irrigation Engineering

The engineering functions of the Irrigation Department should be transferred to a ministry in which other major engineering works are being performed. Preferably this should be the proposed new Ministry of Engineering Services; otherwise the function should be joined with hydro- and steam-electric organizations. The Irrigation Department of the Ministry of Agriculture should retain responsibility for operation and maintenance of irrigation projects, for supervision of application of water to the land, and for relations with water users.

h. The New Cooperative Societies Department

The Cooperative Societies Department is now under the Ministry of Cooperation and Commodity Distribution, and handles urban consumer and producer cooperatives as well as agricultural cooperatives. The development of agricultural cooperatives is, however, so intimately related to improvements in rural credit, marketing and processing that a Cooperative Department should be established under the Ministry of Agriculture. This Department should take over the cooperative program now being planned by the Ministry of Land Nationalization as well as the agricultural cooperative program of the present Cooperative Department.

i. Other Departments and Offices

The State Agricultural Credit Department, the Veterinary Department, the Fisheries Department, and the Forests Department should continue in their present functions. The Veterinary Department should work in close cooperation with the Agriculture Department in developing better animal husbandry practices. It should eventually add to its responsibilities the work of inspection and certification of livestock products.

The Agricultural and Water Resources Development Corporation now provides funds for financing the Five-year Agricultural Development Plan and is responsible for coordinating all activities relating to it. The proposed planning staff should take over most of the planning functions now assigned to the Corporation and the Corporation should be responsible for providing funds as heretofore. The Corporation should be directly under the joint secretary for planning, who would also be head of the planning staff.

The State Agricultural Marketing Board is now under the Ministry of Commerce. Although legislation was passed in 1950 which will make it an independent board responsible to the President, it has not been put into effect. A board responsible for marketing agricultural commodities abroad would normally be under the Agriculture Ministry or the Commerce Department. However, in view of the importance of SAMB and the tremendous importance of rice both as the basic food in Burma and a major source of incomes for cultivators, the SAMB should be an independent board directly under the President. The composition of the board should be altered to provide adequate representation of all agencies concerned.

Field staffs are now maintained separately by the Agriculture Department, the Irrigation Department, the Ministry of Land Nationalization, Commissioner for Settlements and Land Records, the Co-operative Department, and State Agricultural Marketing Board. More efficient operation would be possible if services and facilities such as transportation, housing, clerical and administrative staff were provided on a common basis. In addition to lower overhead costs it would facilitate coordination between the various officers. Under the Pyidawtha plan field officers from various departments are expected to work together in District and Township Pyidawtha committees. Consolidation of office facilities would carry this one step further.

The post of Financial Commissioner (Land and Rural Development) should be abolished. The position is an anachronism remaining from the colonial days when collection of land revenue was considered to be the principal government function in agriculture. The changeover to the philosophy that the Government should provide services to the farmer means that the importance of revenue collection from farmers no longer justifies the services of the top civil servant in the agricultural field. Instead, the secretary of the new ministry should be given a rank equivalent to that of Financial Commissioner.

D. INCREASE OF AGRICULTURAL PRODUCTION

The several measures for increasing agricultural production suggested in this Report are new to Burmese agriculture. The intensification of present cultivation is discussed with consideration given to what cultivators would probably do instead of what they could do to improve their farming operation. Intensification of cultivation is considered both for those practices that are possible under present methods and for those that would be possible under more advanced farming methods. Reservoir irrigation, impounding large volumes of water, as distinct from stream diversion systems, is suggested as a means of increasing production and is discussed in relation to farming methods employed. It is proposed that demonstration farms be established and that extension services be expanded in order to point the way of future agricultural development using modern methods. In the long-range view research is essential to increased agricultural production. Areas of specific deficiency are indicated. Lastly, mention is made of the restoration of abandoned land.

1. INTENSIFICATION OF CULTIVATION

Intensification of agriculture is considered to be potentially the most important means of increasing agricultural production because, in its various forms of application, it can be applied to all cultivated areas. The direction and degree of intensification is dictated by need as well as by the natural resources upon which it would be applied. The need of the cultivator, although indirectly tied to the needs of the nation, is usually concerned with basic requirements, particularly food. The nation needs rice exports to support her Pyidawtha (social welfare) program. The achievement of increased production by intensification of cultivation rests with the cultivator.

a. Under Present Farming Methods

(1) The Use of Fertilizer

With present farming methods, the intensification of cultivation is more likely to result from new approaches to the old problem than from renewed efforts along relatively unsuccessful past methods. The use of chemical fertilizer is an example. This might succeed where other methods fail because of its low labor effort and positive, sometimes dramatic, results. Before the war fertilizers, with few exceptions, were too expensive to use, and the variety of their combination was not so diverse or their preparation so complete as at the present time. Today almost any fertilizer combination can be had, such as pelleted to facilitate spreading and storage, or with trace element compounds for correction of specific deficiencies. More important perhaps is the degree of concentration and low cost of present chemical fertilizers. Their use does not require strenuous effort. They have never enjoyed widespread use in Burma, and their novelty would be a psychological advantage. Furthermore the use of chemical fertilizers would be a short-term investment with immediate returns. Their effectiveness would be limited by a general ignorance of their value and of their application, but demonstrations would be easier than for many other methods of intensification.

Chemical fertilizers offer the greatest benefit at the least cost for most crops. The maximum economic return comes with the first 50 or 100 pounds applied per acre. Without machinery it is extremely difficult to distribute properly small amounts of fertilizer per acre. Therefore all fertilizer estimates are made for the application of 100 pounds per acre.

Experiments in the use of chemical fertilizers have been conducted in several areas in Burma. These tests, carried out during the past 25 years, demonstrated favorable responses in most crops, and covered the use of many chemical fertilizers commercially available today. Table VIII–8 summarizes the possible applications of chemical fertilizers on crops indigenous to Burma. The fertilizer requirements for particular crops, indicated in the table, will vary with the nutrient condition of the soil.

TABLE VIII – 8

FERTILIZER RECOMMENDATIONS

Crop	*Fertilizer*	*Application*	*Remarks*
Gramineous Paddy	Sulphate of ammonia ±20%	100 lbs./acre broadcast or drilled	Continued use lowers soil pH with consequent complications. The crop may lodge
	50% Ammonium sulphate 50% Super-phosphate ±20%	100 lbs./acre 100 lbs./acre drilled or broadcast	Low-concentrate fertilizers expensive due to freight and handling costs
	Ammonium phosphate 20–20–0	100 lbs./acre broadcast or drilled	Best effect per unit of cost
Sugar Cane	Sulphate of ammonia ±20%	100 lbs./acre broadcast or side-dressed	Solubility favorable
	Ammonium phosphate 20–20–0	100 lbs./acre broadcast or side-dressed	Best effect per unit of cost if soil phosphorus deficient
	Nitrate of soda ±20%	100 lbs./acre broadcast or side-dressed	Solubility unfavorable
Dicotyledenous Cotton	Complete ammonium phosphate 17–45–0	100 lbs./acre broadcast, drilled or side-dressed	Best effect per unit of cost
Other Crops	Ammonium phosphate 20–20–0	100 lbs./acre broadcast, drilled or side-dressed	Best effect per unit of cost

Row crops are often benefited considerably by side-dressing fertilizers as the crops grow. The practice is limited to a mechanized operation. Placement can significantly influence the utilization of fertilizers, and mechanization affords the best means of varying such placement.

The diversity in the requirements for different crops and the varieties of the soil types upon which they are grown deny a detailed discussion of relative benefits from fertilizer application. A discussion of rice production and the use of fertilizer will serve as an example. Chemical fertilization of rice has not been completely tested in Burma. The evidence available indicates that, in general, the application of 100 pounds per acre of a 20–20–0 fertilizer will increase rice yields an approximate 20% to 30%. The method of application, the type of fertilizer, the time of application and evenness of distribution all enter into the ultimate results on any plot of soil. Very great differences may be expected in yield and, in extreme cases, harmful or disastrous results can occur by overdosage or improper application. The use of chemical fertilizers seems to offer the quickest increase potential in rice production that is readily adaptable to present agricultural methods. The relationship between the increase in rice production from fertilizer and cost is discussed in Paragraph D–6–b of this chapter.

(2) Partial Mechanization

Another means of intensifying cultivation without instituting radical changes in cultivation methods is partial mechanization of the soil preparation and harvesting operations. Experience in Burma has demonstrated that custom plowing during the dry season is possible under restricted conditions. Although mechanical equipment cannot efficiently operate on small plots, given an area of ten or more acres without bunds, mechanical plowing can prepare the soil faster and cheaper than primitive methods, and do it much better. If such ten-acre plots are sufficiently numerous, a custom plowing center would be feasible. An example for consideration would be a plowing center employing five Farmall Super MD tractors. A unit of this size would justify the establishment of a small service and repair shop to insure proper maintenance of equipment. From Table VIII–9 (*see p.* 154) it is calculated that custom plowing costs approximately K4·00 per acre without consideration given to the movement of machinery and equipment from one field to another, or the cost of a mobile shop. Assuming that 10% of all time worked is so consumed, and the cost of a mobile maintenance unit is K1·19/acre, the resultant cost per acre for mechanical plowing is approximately K5·19. This figure embraces all costs, as listed in Table VIII–9. A calculation of cost for plowing the same area with oxen, during the beginning of the wet season, under unpleasant conditions and doing an inferior job amounts to K18·3 per acre as calculated from data listed in Table VIII–9.

Essentially the same program is possible for the utilization of separators in conjunction with harvesting grain. One such machine, with a capacity of 17,500 pounds per ten hours, is able to thresh the yield of 13 acres of paddy daily. Stationary threshers need not be confined to threshing paddy. A very wide variety of threshing discs is available for the handling of pulse crops, wheat and cereals generally. Hand-reaped bundles of panicles are presently hauled from the field to the threshing-floor, and to haul them somewhat farther would probably not be sufficiently critical to discourage the use of a mechanical separator. The thresher is easily moved. The quality of the separation and the reduction of lost and damaged grain would reduce the cost of using the thresher. A considerable advantage lies in the rapidity of handling.

The cost of threshing rice mechanically approximates K8·7 per ton, as calculated from Table VIII–9. Present costs, as taken from Table VIII–9, approximate K22·8 per ton. The difference is more than cost, for grain mechanically separated is of considerably higher quality owing to less breakage, and there is more of it due to reduced loss in separation.

Partial mechanization, as analyzed above, is therefore one approach to intensification of agriculture permitting more land to be cultivated, by reason of early plowing, and the obtaining of more and better grain through mechanical separation. Under unusual cases of available moisture during the dry season, either by precipitation or irrigation, a combination of custom plowing and mechanical threshing would permit double cropping, crop rotation and the use of green manures in the cropping pattern.

(3) Simple Improvement Techniques

(a) Storage and use of manure. Within the reach of, and often known by, the individual cultivator are numerous simple means of intensifying cultivation. None of them is easy. The average land holding of approximately 12 acres usually has a single pair of oxen to supply farm power. Two oxen normally produce six tons of manure annually, approximately one half the value of which is lost to evaporation and leaching due to improper storage and handling. Accordingly, under common management, one quarter of a ton of manure per acre is used on the land. This quantity has a beneficial effect amounting to an increased yield of less than 5%. The use of manure involves a discouraging labor effort. The result is that the value of manure is limited and its use not fully exploited, although probably well known. In Europe the degree of utilization of animal manures is very high, and special attention is given to its collection and storage. By placing fresh manure in a concrete basin, so constructed as to drain the liquid portion into a subterranean tank, it is protected from leaching. The liquid manure is drawn from the tank and sprayed over the fields just prior to seeding. The solid portions are stacked in the field and spread by hand. Such a system would be indeed beneficial for agricultural soils of Burma but the costs involved for so storing and handling manure are probably prohibitive for the average Burmese cultivator. However, a number of methods which would involve little expense have been developed by the Department of Agriculture.

(b) Composting. The use of compost in Burma has been tested experimentally with favorable end results. Composting serves the dual purpose of soil improvement, much as does green manuring. The usual compost requires the hand mixing of cut and dried vegetation with farmyard manure and soil at an approximate ratio of 3:2:1. After repeated mixing over a period of six to eight months, the compost is spread at the rate of ten or more tons per acre. An average farm would require 120 tons of compost for 12 acres of land. That tonnage would have to be handled several times, being finally spread in May during the busiest season of the year.

Composting is a practice typical of gardening, and highly beneficial. It is economically feasible only if labor is to remain cheap, which is contrary to the objectives of the program. Bulletin No. 29 of the Department of Agriculture of Burma shows that composting is not justified economically unless labor is cheap. The increased yield of paddy by the application of 100 pounds per acre of a 20–20–0 chemical fertilizer is equivalent to the increase in yield from ten tons of compost, and the cost of chemical fertilization is about half that of composting. Furthermore, the quantities of manure available for proper composting are not sufficient for large-scale application. Composting is therefore recognized as an excellent means of intensifying cultivation but too difficult and too costly to merit widespread use without partial mechanization.

(c) Other. The intensification of cultivation by better soil preparation, pest control, crop rotation, green manuring, and double cropping does not achieve optimum results under conditions of primitive agriculture. It is doubtful that soil could be much

	Labor					
	Mechanized			*Hand or Oxen*		
	Acres/ Day	*MD/ Acre*	*Cost/ Acre*	*Acres/ Day*	*MD/ Acre*	*Cost/ Acre*
			K			*K*
Soil Preparation						
Plow	10*a*	0·1	0·5*b*	0·5*i*	2·0	5·0*c*
Harrow Plow	30	0·033	0·16	—	—	—
Disc Harrow	40*h*	0·025	0·13	—	—	—
Border Harrow	100	0·01	0·05	—	—	—
Pegtooth Harrow	—	—	—	5·0*i*	0·2	0·5
Fertilizer Application						
Drill and Fertilizer	50	0·03	0·15	—	—	—
Surface Spreading	60	0·025	0·13	—	—	—
Side-dressing	16	0·062	0·31	—	—	—
Broadcast	—	—	—	5·0*f*	0·2	0·5
Seeding						
Seeding (Groundnuts, Maize, Sesamum, etc.)	20	0·06	0·25	—	—	—
Drill (Grains)	60	0·017	0·08	—	—	—
Seed, Fertilizing, Furrowing	16	0·093	0·46	—	—	—
Transplant and Pull	—	—	—	0·12*e*	8·0	20·0
Broadcast (or End-gate Seed)	80	0·012	0·06	3·0	0·3	0·8
Cultivation						
Springtooth	40	0·025	0·12	—	—	—
Row Cultivation	30	0·033	0·16	—	—	—
Hoe (or oxen-cultivate four times)	—	—	—	0·25	4·0	10·0
Chemical Treatments						
Dusting	60	0·017	0·08	—	—	—
Harvesting						
Bind	16	0·124	0·62	—	—	—
Combine	12*d*	0·166	0·82	—	—	—
Reap	—	—	—	0·2*g*	5·0	12·5
Thresh and Winnow	12*d*	0·166	0·82	0·27*i*	3·7	9·2
Picking (maize) (machine)	14	0·071	0·35	—	—	—
Picking, Hand (Groundnuts, etc.)	—	—	—	0·2*g*	5·0	12·5
Digging (Groundnuts)	20	0·05	0·25	—	—	—
Digging, Hand	—	—	—	1·0	1·0	2·5
Cleaning (Groundnuts)	15	0·134	0·66	—	—	—
Other	25	0·04	0·2	—	—	—

TAB

CULTIVATIO

	Cost	*Dep. Rate*
Soil Preparation	*K*	*Year*
TD9 Crawler	34,200	10
TD6 Crawler	27,200	10
Farmall Super MD	14,900	8
Farmall Super C	9,900	8
Border Harrow	4,130	5
Plow, 3-Disc	2,750	5
Harrow Disc, 4 Gang	1,990	5
Plow-Harrow, 8	4,920	5
Fertilizer Application		
Lime Spreader	2,190	3
Seeding		
Tool Bar Attachment Seeder Attachment Fertilizer Attachment Middle Buster	4,900	5
Grain Drill with Fert. Attachmen	4,030	5
End-gate Seeder	631	3
Cultivation		
Row Cultivator	4,560	5
Spring-tooth Cultivator	500	5
Chemical Treatment		
Duster	3,000	5
Harvesting		
Shaker (Groundnuts and Pulses	3,080	5
Binder	8,300	8
Combine (Groundnuts)	11,900	8
Combine (Grain, etc.) 6	16,010	8
Separator	17,600	8
Picker (Maize)	7,970	8
Picker (Cotton)	47,500	8
Digger (Groundnuts)	950	5
Other		
Wagon	2,300	8
Cleaner (Groundnuts)	8,900	8

VIII - 9

COST ANALYSIS

Machinery

Dep. Cost	6% Int.	Maint. and Oper.	Total Cost/Crop	Cost/Acre[q]
K	K	K	K	K
			2,740o	5·48
1,710j	1,030j		2,176f	4·35
1,360j	816j		1,376l	2·75
930j	446j		913m	1·83
620j	293j			
413j	124j	41n	578	1·15
275j	83j	28n	386	0·77
199j	59j	20n	278	0·55
492j	148j	49n	689	1·38
365	65	37	467	0·93
490j	147j	49n	686	1·37
403j	121j	40n	564	1·13
105j	19j	11n	135	0·27
456j	137j	46n	639	1·28
50j	15j	5n	70	0·01
300	90	30	420	0·84
619k	185k	62n	866	1·73
515	250j	52n	817	1·63
1,490	715k	149n	2,354	4·71
1,000	480j	100n	1,580	3·16
1,100	528j	110n	1,738	3·47
1,000	477k	100n	1,577	3·15
5,937	2,850k	599n	9,381	18·76
190	57k	19n	266	0·53
144j	69j	14n	227	0·45
1,110k	535k	111n	1,756	3·51

Animal and Equipment Costs[r]

	Cost	Dep. Rate	Dep. Cost	6% Int.	Maint. and Total Cost/		
					Oper.	Cost/Cr.	Per acre
All Operations	K	Years	K	K	K	K	K
Oxen, pair	500	6	83	30	8	121	10·1
Plow, Hand	100	8	12	6	1	19	1·5
Yokes	25	3	8	1	1	10	·8
Cart	300	10	30	18	3	51	4·2
Shed	30	1	30	2	3	35	2·9
Hand Tools	40	3	13	2	1	16	1·3

Common Costs (unless otherwise specified)

	Rate/Acre	Cost/Acre (Kyats)		
		Present	Irrigated	Modern
Land Revenue	K0·9	0·9	0·9	0·9
Fertilizer (20–20–0)	100 lbs.	—	35·0	35·0
Seed	46 lbs.	3·0	3·0	3·0
DDT Dust (10%)	10 lbs. @ K1·6	—	—	16·0
325 Mesh	60 lbs. @ K0·3	—	—	20·0

Yield Increases with Improved Practices (% Increase)

	Rice	Sesamum	Maize	Sugar Cane	Pulses	Groundnuts	Tobacco	Cotton
Operation								
Soil Preparation	5	5	5	10	5	5	5	5
Fert. and Placement	30	40 (30)	10 (8)	30 (20)	20 (15)	30 (20)	30 (20)	40 (30)
Seeding	—	10	15	—	10	10	—	10
Furrowing	—	5	—	—	5	10	—	5
Insect-Fungus Con.	—	5	10	—	5	15	15	15
Preflooding	—	(80)	—	—	(15)	—	—	—
Harvest Quality	—	—	—	—	10	5	—	—
Water Control	15	(80)	10	25	(15)	25	15	20
Cultivation	—	—	10	10	10	5	5	10
Irrigated without Fert.	15	80	10	25	15	25	15	20
Irrigated with Fert.	45	110	18	45	30	45	35	50
Modern without Fert.	20	105	50	45	60	75	40	65
Modern with Fert.	50	145	60	75	80	105	75	105

NOTE.—*Lower yields resulting from hand placing of fertilizer are indicated by the numbers in brackets.*

a Farm Machinery Publications.
b @ K5/MD.
c @ K2·5/MD.
d Variable according to crop; here assumed 1,000-acre crops; grains 16 acres/day.
e 1MD = Transplants pulled for planting ⅘ acre; 1MD = ⅙ acre transplanted; 1MD = ⅓ acre reaped Settlement Report Shwebo.
f Estimated.
g Hand picking 100/day; crops estimated @ 500/acre (Marketing Groundnuts).
h Estimated bordered acreage prepared.
i Agric. Survey No. 17, 1932.
j 6 months or 1 crop depreciation period.
k 1 year depreciation period per crop.
l 500 acres; fuel, lube, parts; K25/machine day; Rice ·1126, days Sesamum ·212.
m 500 acres; fuel, lube, parts; K20/machine day.
n 10% depreciation.
o 500 acres; fuel, lube, parts; K35/machine day.
p 500 acres; fuel, lube, parts; K30/machine day.
q Based on 500-acre crop.
r Based on 12-acre crop.

better prepared than at present, using primitive implements and animal power. A primitive plow reaches three to five inches into the soil and stirs it without folding it over uniformly. The operation is repeated several times in order to pulverize fairly well the soil or puddle it in the case of paddy. No variation of this system is possible. The only means of improving soil preparation is to use equipment that will handle the soil according to its needs. That may involve subsoiling, breaking hardpan, middle breaking, stubble harrowing, deep plowing, disc harrowing or a wide variety of other treatments. None of these practices can be used without mechanical power. Green manuring is another example. A green manure crop must be plowed under when its development has reached a certain stage of succulence. Primitive implements and animal power are not capable of performing that operation, particularly in the heavy soils extending over most of agricultural Burma.

The use of crop rotations and double cropping, as means of intensifying primitive cultivation, is not generally practiced. For most of Burma the principal crop is rice, and two thirds of all cultivated acreage is annually devoted to its production. Crop rotation as an improvement measure cannot be permitted to interfere materially with rice production. Crop rotation must therefore include a second crop. Double cropping with non-mechanized agriculture requires that soil preparation and harvesting operations be speeded, and that irrigation water or sufficient rain be available to raise a second crop.

The new and very effective means of insect control, arising from the development of nerve killing compounds, are of limited use to the hand cultivator. They are most effective when distributed by special machinery designed for use with mechanical farm power.

b. Mechanized and Partially Mechanized

(1) Application Limited

Complete mechanization with latest farming techniques can achieve a degree of intensification of agriculture far beyond that obtained by hand methods. However, the required conditions will be difficult to meet in Burma. First, mechanization should be confined to highly productive soils to justify its relatively high capital investment and operational cost. Secondly, it should be located in an area of the country not too far removed from central markets and the sources of mechanical supplies for demonstration farms engaged in producing critical commodities. Alternatively, a system of decentralized servicing stations could be established. Thirdly it must be operated on a modern, scientific agricultural plan, adapted to a scale consistent with efficient use of mechanical equipment. An average economic unit would be about 500 acres. Lastly, it must be properly organized and supervised with competent personnel. Such conditions are not impossible and in due course could very well become common as in many other countries. At the outset, programming on a modest scale, perhaps in the form of demonstration farms to gain experience, would be desirable and more compatible with investment of foreign exchange in equipment than would large-scale development.

(2) Advantages

(a) Efficient farming. Modern agriculture automatically permits crop rotation, green manuring and the fullest use of natural and chemical fertilizers. Practices that are impossible under primitive agriculture are an integral part of modern farming. Double cropping becomes a standard practice, water permitting, and farm output can often be more than doubled.

Mechanization is the key to modern farming. Machine power is cheaper, more versatile, and easier to handle than are oxen. Farm equipment is available for doing every job on the farm and is designed to fit practically every unusual characteristic that an agricultural area can present. Seed-bed preparation using mechanical equipment is superior to that of primitive plows and harrows. One operation with mechanical equipment does the work of four or five primitive operations, and does it better. The placement of fertilizers, seeding, furrowing, harvesting and cultivation are more efficient and cheaper with mechanical equipment. Some operations, such as chemical insect control and bulk handling are possible only with mechanized farming. About 10% of all paddy acreage now occupied by bunds could be farmed under mechanization by reduction and realignment of bunds along contours. Instead of depleting the soil, farming with machine equipment actually improves the soil medium and the use of soil-improving crops becomes possible.

(b) Soil improvement. Crop rotations, for example, have the objectives of greater economic yield through better soil utilization and soil improvement. Different crop types can be grown for building soil organic matter for protecting the soil, and for controlling weeds and insects. Soil fertility is better maintained by root zone feeding at variable depths. To be effective, crop rotations should follow the basic cycles of green manure, row crops, small grains. Green manure should be mixed with an adaptable legume, of which a number are currently raised in Burma as cash crops. Green manure contributes to the tilth of the soil and supplies a desirable level of nitrogen and carbon in a balanced ratio. Soil drainage improves the land and often, depending on the green manure type, produces a grazing benefit that may cover the cost of the practice.

Legumes tend to exhaust soils of phosphorus. Consequently phosphatic fertilizers should be used with hay crops where required. Row crops follow green manure in order to utilize the high nitrogen level established by green manure crops. In general, row crops draw heavily on the supply of all soil nutrients. They require cultivation and therefore expose the soil to erosion. Consequently row crops should not be grown for more than one quarter or one third of the rotation period. Small grains follow row crops as moderate users of soil nutrients and afford soil erosion protection. Small grains following legumes are sometimes subject to lodging due to a superabundance of nitrogen in the soil. If necessary, as is probable in most areas of Burma, it is important that phosphatic fertilizer be applied in sufficient quantity to balance the high soil nitrogen level. Crop rotation on paddy lands is predicated upon double cropping and controlled irrigation. The selection of a suitable rotation is difficult because of the heavy clay soils and the traditional preference for rice production. Upland areas are capable of more effective crop rotations and permit a wider selection in rotation. The cost of establishing crop rotation is small and the benefits are significant, both immediately and in a long-range view.

Although water deficiency during the dry season, except with irrigation, precludes the possibility of green manuring in much of Burma, there is need for it. There is a major and general deficiency of nitrogen in soils that have been cropped for extended periods. The organic content of nearly all soil types in Burma is also low. The practice of green manuring can correct both deficiencies to a considerable extent. To increase the total and available nitrogen in the soil it is necessary that a legume be used for the green manure cover crop. There are a number of indigenous legumes that are suited to the soils and climate of Burma, principal of which are Crotelaria, Lathrus, Psophocarpus, Mucuna and Vigna species. A non-legume, plowed under for green manure, will decompose slowly due to the paucity of soil nitrogen upon which soil microorganisms depend for their activity. Consequently, decomposition ceases, or nearly so, with an exhaustion of available nitrogen reserves, and intermediate products of decomposition are released. Some of these are toxic to plants. A crop planted into an improperly decomposed, green-manured field would immediately suffer from shortage of nitrogen.

Many beneficial effects of green manuring other than replenishment of soil nitrogen can be had in terms of improved soil tilth, greater availability of certain nutrients held in the organic fraction of the soil, such as nitrogen and many trace elements, and the preservation of many nutrients in the body of the cover crop that might otherwise be lost to leaching. The practice of green manuring is readily adaptable to crop rotation patterns.

(c) Diversification of farming. In those areas of Burma that are suitable for livestock, principally on the Shan Plateau and to a lesser but nevertheless important degree in the Dry Zone, a diversified farming program would have merit. Perhaps a fattening program of short duration could even be carried out in the Delta area, should it develop that forage legumes become established in crop rotations of lower Burma. The production of oleaginous crops often coincides with conditions conducive to good livestock production. A combined operation utilizing green manure for soil improvement and livestock production, grain production as a cash crop, and groundnuts or sesamum for marketing oil and for feeding concentrates to dairy stock or hogs warrants investigation.

(d) Lower costs. Cultivation costs under mechanized agriculture and under present cultivation methods have been analyzed (Table VIII–9). The costs have been prepared in three parts to show costs now, costs with present cultivation methods but with ample irrigation water throughout the year, and costs of mechanized farming with irrigation. The differences in yield resulting from these varying practices are significant even though based on limited data. Estimates of total costs from each of the cultivation methods followed are assembled in Table VIII–10 (*see next page*). These estimates are based on probable costs after establishment of enough mechanized farming units to support adequate maintenance and repair services. Initial costs of mechanized farming may be substantially higher.

The costs of cultivation have been separated into those of labor, machinery or animal and equipment expenses, and common or other costs. For calculation purposes, the various operations such as soil preparation, fertilizing, seeding, chemical treatment, cultivation and harvesting, have been listed separately with a varied choice of procedure according to the crop grown and the prevailing conditions. Table VIII–9 reflects all costs of cultivation, as applied to individual operations.

Labor, as shown in Table VIII–9 is divided into that for mechanized and that for hand or oxen. It is assumed that labor under hand or oxen methods will continue to earn the current wage of K2·5 per day. Semi-skilled labor necessary for the maintenance and operation of mechanized equipment is expected to receive the wage of K5 per day. The daily work capacity of machinery and the man-days and cost per acre, at the pay rates listed above, are recorded for individual farming operations. It should be noted that the transition to the higher wage is not to be regarded as a handicap but would constitute an instance of direct achievement of the end objective of the entire development program which is to raise the relative income of the individual.

That portion of Table VIII–9 relating to the use of modern farm machinery lists the cost to Government of equipment units delivered in Rangoon and the depreciation rate of equipment in years. Depreciation cost is recorded for the period of cultivating one crop. In a few cases where a single crop occupies land for an entire year, machinery depreciation costs cover the same period. The same principle applies to the use of special equipment that serves the requirements of a single crop. It is assumed that the Government would finance any mechanized cultivation program. Accordingly a 6% interest rate has been taken as an expected revenue to the Government for provision of capital. Maintenance expenses have been calculated at a 10% value of the annual depreciation for all pieces of equipment except power units. Tractors have been considered to cost from K20 to K35 per day, according to size, for maintenance and operation, exclusive of labor. The final columns of the machinery section of Table VIII–9 show the cost per acre and the total cost per crop of each unit of equipment.

Animal and equipment costs have been taken from a publication entitled "A Colonization Scheme for Uncultivated, Reclaimed and Disforested Areas." In order to establish an equitable comparison with mechanized agriculture, and to reflect a more accurate picture of recurring costs, the same considerations of depreciation and interest have been shown for hand or oxen agriculture costs as those for mechanized costs. Costs for hand or oxen methods are based on an average farm holding of 12 acres. Mechanized costs are calculated for a 500-acre farm.

The common costs of land revenue, fertilizer, seed, insecticides and other materials are assembled in Table VIII–9 as a general guide to specific needs. Any or all of these requirements vary with individual crops, and that variation has been taken into account in the final calculation of cultivation costs for each crop.

The use of fertilizers and the use of modern machinery produce yields considerably in excess of those of present agricultural methods. An estimate of the increase in yield for each of the operations of soil preparation, fertilizer use and its placement, seeding techniques, furrowing, insecticide usage, preflooding or water control, cultivation and harvest quality has been prepared. Increases are expressed in terms of percentage.

The proper preparation of soil involves plowing,

TABLE VIII – 10

PER-ACRE CULTIVATION COSTS

(in kyats)

Crop	*Labor*			*Machinery*		*Other*			*Total without Fert.*			*Total with Fert.*		
	Present	*Irri-gated*	*Mod.*	*Present*	*Mod.*	*Present*	*Irri-gated*	*Mod.*	*Present*	*Irri-gated*	*Mod.*	*Present*	*Irri-gated*	*Mod.*
Paddy	49·7	50·2	1·97	20·8	26·86	3·9	38·9	38·9	74·4	74·4	34·7	109·9	109·9	69·7
Sesamum	10·75	16·25	3·04	20·8	32·96	3·9	38·9	38·9	35·5	41·0	39·9	66·6	76·0	74·9
Maize	24·25	26·75	2·02	20·8	24·03	3·9	38·9	38·9	49·0	51·5	26·7	84·0	85·5	65·0
Sugar Cane	109·5	119·5	63·36	33·7	34·08	59·9	94·9	94·9	203·1	213·1	157·3	235·1	248·1	192·3
Pulses	24·35	31·65	2·96	20·8	31·72	3·9	38·9	38·9	49·0	49·0	38·6	91·3	91·3	73·6
Groundnuts	25·75	28·95	3·88	20·8	42·35	11·9	46·9	41·4	58·5	58·5	58·1	96·6	96·6	93·1
Tobacco	43·0	45·65	30·57	20·8	17·49	3·9	38·9	38·9	67·7	67·7	52·0	105·3	105·3	87·0
Cotton	24·25	26·75	13·51	20·8	22·54	3·9	38·9	38·9	48·9	48·9	40·0	86·4	86·4	75·0
Wheat	14·9	22·2	1·34	20·8	20·40	3·9	38·9	38·9	39·6	39·6	25·7	81·9	81·9	60·6
Forage Grass	—	—	·86	—	9·23	—	—	38·0	—	—	13·0	—	—	48·1
Green Manure	—	—	·86	—	9·23	—	—	3·0	—	—	13·0	—	—	—

harrowing, and sometimes subsoil tillage, leveling and suitable mulching or other surface preparation. Tractor-drawn machinery allows any variation of soil preparation imposed by soil conditions or by the crop to be grown. Primitive animal-drawn equipment does not. Accordingly, it is calculated that proper soil preparation using modern machinery should improve the yields of all crops by an average of 5%. In the case of sugar cane the yield should be greater because of the drainage requirements of the plant.

The use of fertilizers increases yields about 30%, according to experimental testing in Burma. The method of placing the fertilizer may vary this yield significantly. Modern machinery is capable of correct fertilizer placement or side-dressing and can produce a still further increase in yield. The lower yields resulting from hand placing of fertilizer are indicated by the numbers in brackets in Table VIII–9.

Seeding directly affects crop yields. Few crops other than some small grains are best planted by hand broadcasting. Machinery seeds any crop uniformly as to both depth and spacing and fully utilizes soil to the best advantage of the crop sown. A distinct advantage of machine sowing is the considerable saving in seed that results. The average increase in total crop yields with machine seeding is about 10%.

Certain crops grow better if the soil is formed into furrows and ridges. The advantages are ease of irrigation, subsoil irrigation, drainage, and good aeration. The benefits of furrowing soil are related to better water utilization. It is possible to furrow soil with stick plows, but only a high-yielding, profitable crop such as sugar cane permits the operation to be economically justified.

Insecticide treatments have a pronounced beneficial effect on many crops after an infestation is apparent. Others, such as groundnuts, profit from preventive treatments prior to infestation. Crops arranged in machine-seeded rows are most profitably treated for insect control, and mechanized equipment is most effective and economical for distributing the insecticides required. Insect and fungus control measures, both curative and preventive, are estimated to increase crop yields from 5% to 15%.

Preflooding and water control are classed separately according to the crop to which the practice applies and to the soil differences under which the crops may be grown. In loam soils with high water-holding capacity preflooding could be effective with sesamum or pulses under conditions of hand-oxen agriculture. If the farming is mechanized, furrow irrigation may be more effective. Accordingly both benefits are enclosed in brackets to indicate that either the one system or the other can be used (see Table VIII–9).

The collection and grading of pulse and groundnut crops by hand-oxen methods is so inefficient and poor

TABLE VIII – 11

CROP PRODUCTION AND VALUE PER ACRE

(Farm level)

	Yield			*Value*		
Crop	*Present lbs./acre*	*Irrigated lbs./acre*	*Modern lbs./acre*	*Present K*	*Irrigated K*	*Modern K*
Paddy	1,330	1,485	1,950	90·2	103·2	135·5
Sesamum	117	210	286	34·6	62·1	62·1
Maize	537	590	860	69·6	76·6	112·0
Sugar Cane	1,770*	2,210	3,100	389·0	486·0	682·0
Pulses	392	450	705	65·0	74·6	117·0
Groundnuts	546	685	1,121	79·1	99·2	162·5
Tobacco	116†	134	203	75·3	87·1	132·0
Cotton	161‡	193	330	72·5	87·0	148·5

* Jaggery. † Dry Leaf. ‡ Lint.

in quality that machine methods should actually increase yields. Hand picking often leaves rather large quantities of the crop in the field. Modern machinery reduces those losses to a minimum, and, by separation or combine methods, greatly increases the quality of the yield collected. Shriveled or undeveloped seeds, such as groundnut “pops,” are not sacked for sale or shipment but instead may be used as a forage supplement or returned to the soil. Better quality produce meanwhile commands a better market price.

Hand cultivation methods are both difficult and expensive. For these reasons, proper weed cultivation is usually poorly done or not at all. The consumption of nutrient salts by weeds is fully as efficient as that of planted crops. The presence of weeds in competition with a planted crop will reduce crop yields approximately in proportion to their relative density, and may cause yields to decline 90% in extreme cases. Broadcast seeding permits no cultivation. Mechanized farming permits cheap and efficient cultivation which is estimated to increase crop yields an average of 10%.

The various benefits of different farming practices rarely stand alone. One is usually dependent upon the other. The benefits are additive in nature and occasionally more than additive. Tables VIII–10 and VIII–11 (*see previous page*) list production costs and gross income for each of the various methods of cultivation employed. Table VIII–12 summarizes these tables into net returns by crop, according to the cultivation method used.

(e) **Pleasant work for farmer.** Two features of mechanized farming have a bearing on its possible success or failure in Burma. It has been said that Burmans have never used mechanical equipment to a large extent and that for that reason they cannot be expected to operate machines efficiently or to service them properly. This conclusion is not supported by the widespread evidence of the manner in which Burmans have repaired, remodeled and maintained surplus vehicles left in Burma by various military forces after the war. Parts have been hand made when none were available, and a major talent for improvisation has been exposed among some of the Burmese mechanics who, without formal training, have managed to repair such major units of equipment as bulldozers. Experience in Brazil, and with the large land clearing program in Ceylon, as well as experience with mechanized farming in Haiti, indicate that the capacity to learn the use and care of equipment is a talent that all peoples enjoy, given equal opportunities.

With mechanized agriculture, the heavy physical burden that the hand cultivator bears is reduced to the care and operation of machinery. The cultivator directs power where before he often supplied it. The fact is that mechanized farming is not physically difficult, but eliminates forms of labor that may deprive

TABLE VIII – 12

CROP COST, VALUE AND NET RETURN UNDER VARIED PRODUCTION METHODS

(*Farm level*)

Crop	*Cultivated Cost*			*Gross Value*			*Net Return*		
	Present *K*	*Irrigated* *K*	*Modern* *K*	*Present* *K*	*Irrigated* *K*	*Modern* *K*	*Present* *K*	*Irrigated* *K*	*Modern* *K*
Paddy	74·4	74·4	69·7	90·2	103·2	135·5	15·8	28·8	65·8
Sesamum	35·5	41·0	39·9	34·6	62·1	62·1	0·9	21·1	22·2
Maize	49·0	51·5	65·0	69·6	76·6	112·0	20·6	25·1	47·0
Sugar Cane	203·1	213·1	192·3	389·0	486·0	682·0	185·9	272·9	489·7
Pulses	49·0	49·0	73·6	65·0	74·6	117·0	16·0	25·6	43·4
Groundnuts	58·5	58·5	93·1	79·1	99·2	162·5	21·6	40·7	69·4
Tobacco	67·7	67·7	87·0	75·3	87·1	132·0	7·6	19·4	45·0
Cotton	48·9	48·9	75·0	72·5	87·0	148·5	24·6	38·1	73·5

the individual of health or even result in permanently crippling deformities. These benefits would soon become generally recognized, and constitute incentive and encouragement favoring both care of equipment and further extension of mechanization.

2. IRRIGATION

Dry land farming is nearly always limited by the water supply. A common water conservation measure in the Dry Zone of Burma is fallowing. By maintaining a vegetation-free soil surface, the loss of soil moisture through plant transpiration is reduced. At the planting season, fallowed soils contain more moisture than those cropped or covered with weeds. A greater soil moisture reserve at the planting season gives more security that the seeded crop will not be lost from lack of rain. Fallowing does not "rest" the soil but, if done properly, prevents vegetative cover that would draw upon the soil nutrient supply. A distinct disadvantage of fallowing is that it leaves the soil exposed to erosion. About 18% of the cultivated area of the Dry Zone is annually recorded as fallow. Placing the Dry Zone area under irrigation would eliminate the necessity for fallowing land.

a. Increasing Cultivated Acreage

Rather large acreages sown every year in the Dry Zone fail to mature. These crop failures are usually produced by lack of water generally, although floods sometimes wash out or drown planted areas. The sown acreage that fails to mature amounts to an average of 6% of the cultivated acreage of the Dry Zone annually. Irrigation would eliminate such crop failures almost entirely.

Table VIII – 13

INCREASED ACREAGE THROUGH IRRIGATION

Project	*Present Acreage*		*Increase from*		*Acres*
	Fallow	*Abandoned*	*Double Cropping*	*New Land*	*Total Increase*
Yamethin	81,000	27,000	450,000	67,500	625,500
Mu	194,000	64,666	1,078,000	161,500	1,498,166
Pakokku	2,030	676	11,250	1,690	15,646
Loikaw	13,500	4,500	75,000	11,250	104,250
				Grand Total	2,243,562

By removing the hazard of insufficient precipitation, irrigation opens up an entirely new phase of agricultural possibilities in the Dry Zone. The most significant of these is double cropping. Theoretically, double cropping doubles the production of an area. Practically, the degree of increased production through double cropping is dependent upon the degree of intensification that is applied in the area. If irrigation is considered in company with mechanized farming techniques, the additive benefits of all practices are several times greater than doubling of present, single crop production. Double cropping is equivalent to acreage expansion under present cultivation practices, and in Table VIII–13 is so shown.

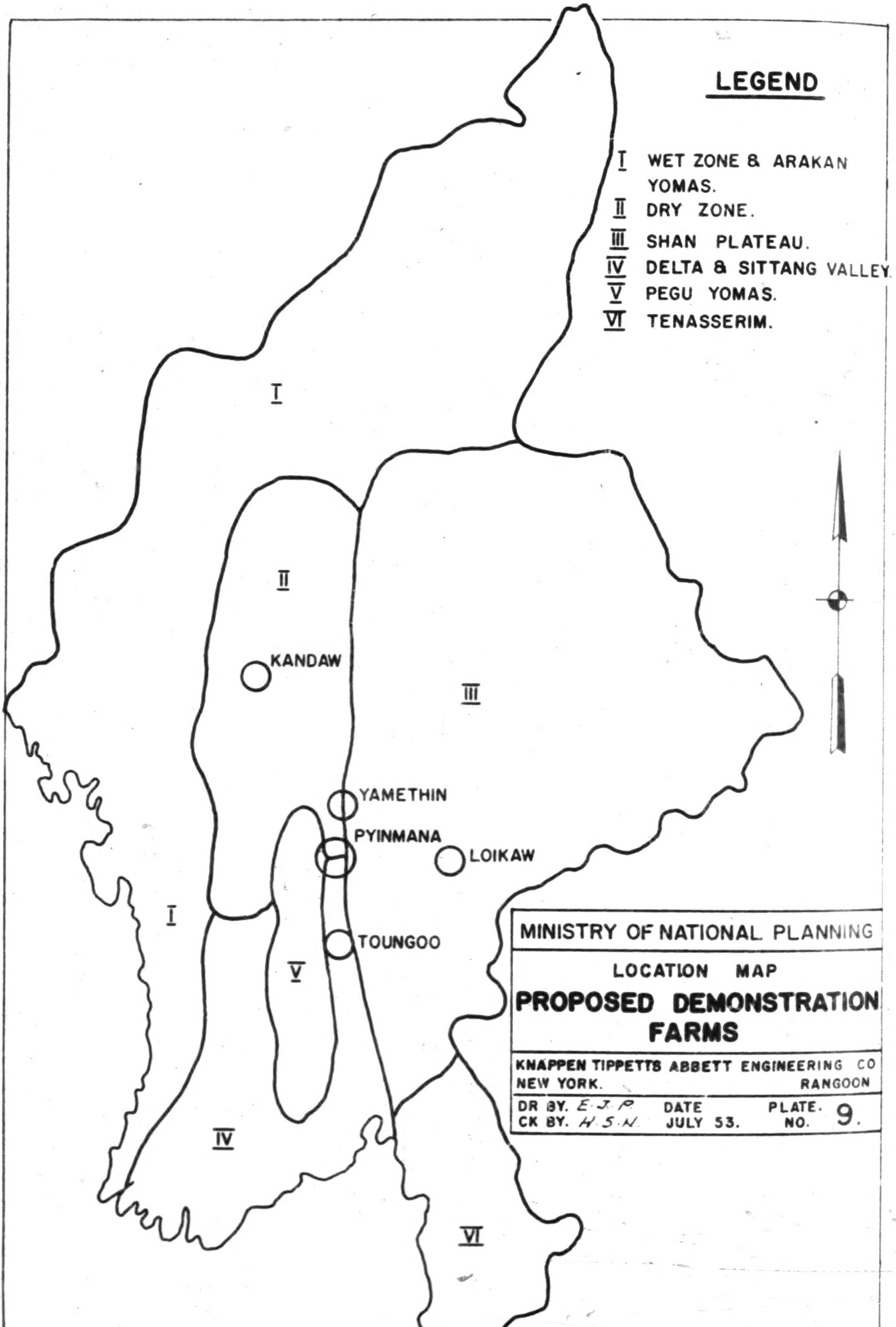
In addition to the placing into cultivation of fallow areas and abandoned crop areas, and the potential double cropping of the total area irrigated, considerable areas that have never been cultivated lie within the canal boundaries of potential irrigation systems. Such areas are usually not Grade I soils, but would probably have been cropped but for reasons of soil texture or shrub cover or forest reserve classification. The availability of water would make such areas potentially cultivable. Table VIII–13 indicates the approximate possible increase, in acres, of cultivation resulting from development of irrigation projects now in the planning stage. The dependence of double cropping upon mechanization of the soil preparation and harvesting operations should be emphasized. The development of new land into cultivated land is accompanied by capital investment in initial land preparation, often land clearing, and initial plowing not easily done under present methods.

b. Impact of Developing Irrigation Projects

The impact of developing the proposed irrigation projects would extend beyond that of increasing cropped acreage. If such development should compel at least a partial mechanization of farming practice in those areas of irrigation, crop production would also be forced into a program of diversification. Using the irrigated soil resource to its utmost economic potential would result in the production of forage crops, and of other crops not previously grown in large quantities in the area. Off-season production would probably become the rule in agricultural commodities such as sesamum, and would permit a more economic utilization of processing facilities. Feed concentrates, produced in the dry season under irrigation, could be fed as a supplement to animals grazing on green manure forage crops in the wet season.

3. DEMONSTRATION FARMS

The introduction of mechanized farming into Burma, however modest the beginning, is a basic requirement for full benefits if proposed irrigation projects are carried out. An analysis of varying benefits according to the cultivation method employed and particularly a consideration of total benefits under the various methods on the Yamethin irrigation project clearly shows that some modernization is necessary to justify fully implementation of the projects.


LEGEND
I WET ZONE & ARAKAN YOMAS.
II DRY ZONE.
III SHAN PLATEAU.
IV DELTA & SITTANG VALLEY.
V PEGU YOMAS.
VI TENASSERIM.
I
II
III
IV
V
VI
KANDAW
YAMETHIN
PYINMANA
LOIKAW
TOUNGOO
MINISTRY OF NATIONAL PLANNING
LOCATION MAP
PROPOSED DEMONSTRATION FARMS
KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK. RANGOON
DR BY. E.J.P. DATE JULY 53. PLATE. NO. 9.
CK BY. H.S.N.

a. Purpose

Lacking a background of experience and knowledge in all phases of improvement in farming, Burma should establish one or more demonstration farm units based upon the best available agricultural information and recommendations of experienced personnel. Such farms would provide accurate cost determinations at a practical level, and would constitute a testing ground for laboratory research findings in the fields of both agronomy and agricultural engineering. Demonstration farms would serve as active training centers for future modern farmers by overstaffing. The future development possibilities of demonstration farms include the formation of custom plowing and harvesting services, growing and distribution of improved seed, the storage and protection of farm products, and possibly farm credit transactions.

The establishment of a single demonstration farm as a testing ground for future development is hazardous and uneconomical and would be inconclusive in evaluating farming practices. It is believed that five such farms should be established to yield an adequate cross section of results.

b. Location

The soils which would most urgently require the practices of improved farming methods are those lying within the boundaries of the proposed irrigation projects. Within the span of both wet and dry zone climates, the Yamethin project offers three areas of investigation. At Toungoo the climate is essentially that of the Delta. Pyinmana lies in the transition zone between wet and dry zone climates. At Yamethin the climate is typical of the Dry Zone. Within a single irrigation project, farming can be demonstrated and tested under all three of the major climate conditions of Burma.

There are times when urgent necessity of the population merits consideration of an irrigation program on a small scale. Such a condition exists near Pakokku, in the heart of the Dry Zone, in an area capable of utilizing a small pump irrigation system. The establishment of a successful demonstration farm in that area would have distinct advantages. An analysis of Pakokku soils reveals that they are relatively fertile and of a sandy texture. In quality they might be compared with desert soils which have not been leached of soil nutrients. Placing this area under irrigation and farming it by mechanized methods might result in the creation of a veritable oasis in the desert. Improved farming under dryland conditions should also be tested because of the very large areas of non-irrigated land. An area in the vicinity of Loikaw provides the conditions of climate and underpopulation that are well suited to this purpose.

Proposed locations for the demonstration farms are shown on the map, Plate 9.

c. Specialization on Demonstration Farms

Each of the suggested locations is particularly suited to demonstration of some specialized form of agriculture. Toungoo, for example, could concentrate on the development of a highly intensified rice production program. The Pyinmana farm could be devoted essentially to sugar cane production. Yamethin could concentrate the activities of its demonstration farm on the diversification of agriculture, Dry Zone soil improvement techniques, and the fattening of livestock. Pakokku, with its sandy soil, is best adapted to the production of groundnuts, and could be used almost exclusively in the field of oleaginous crops. The farm at Loikaw could demonstrate the practicability of combining grain and groundnut production with that of dairy and livestock. The proposed demonstration farms would be similar only in their organization, operation and cultivation techniques. The goals of each farm would be different, with each devoted to the production of an agricultural commodity in short supply within the country or, in the case of rice, of an export commodity of interest to the nation.

d. Organization and Administration

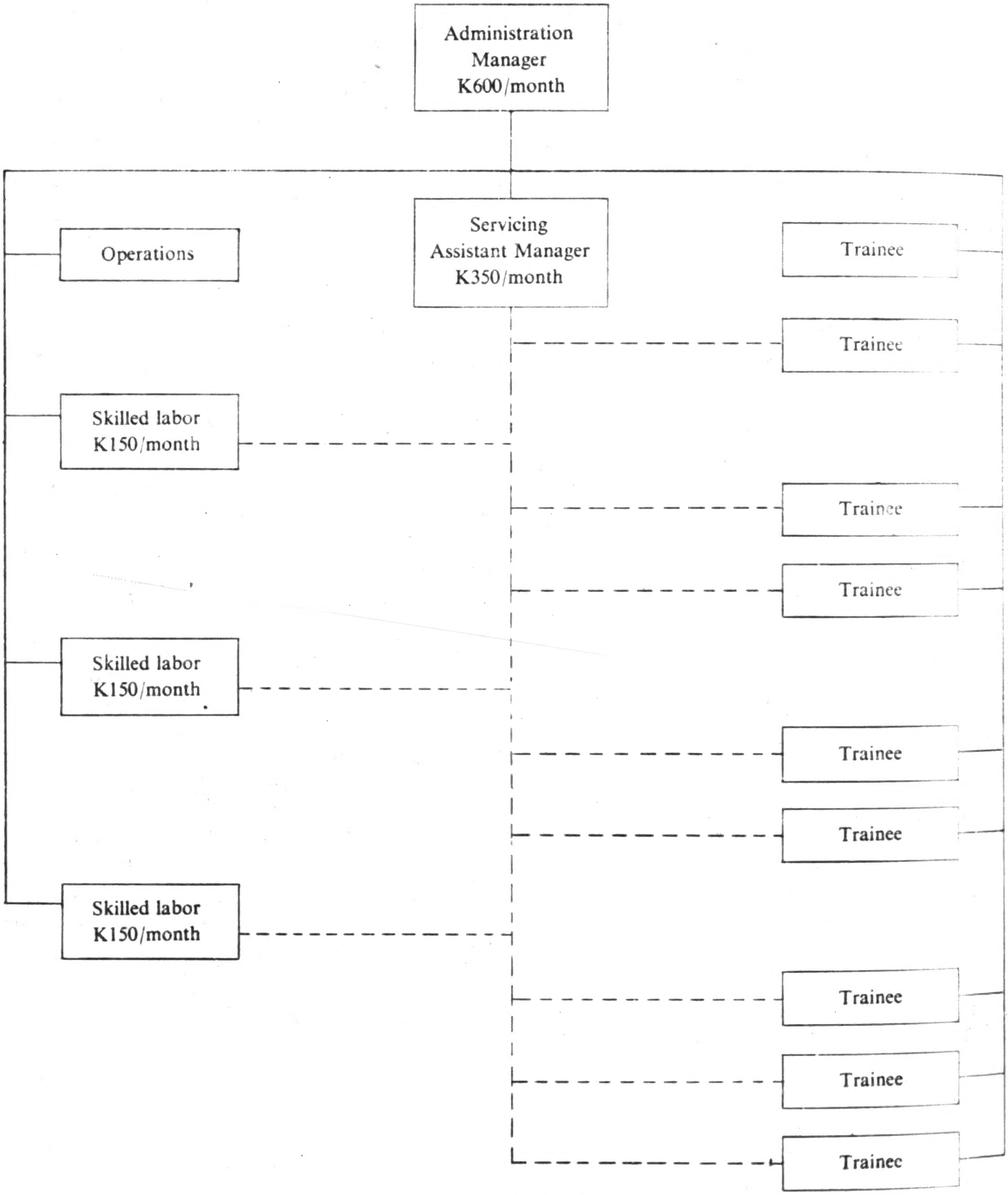
The organization and administration of demonstration farms could be fitted into any one of several present government agencies, but should function best directly under the Director of Agriculture. From the Ministry of Agriculture the necessary land, funds and understudy personnel could be provided.

Planning and initial operation of demonstration farms should be undertaken by foreign personnel with successful experience in the selected types of farming. Within a short period it would be expected that both authority and responsibility would be taken over by Burmese personnel and the foreign specialists released, or retained temporarily in consulting capacities. It is essential that the chain of authority be simple, strong and commensurate with its responsibility. A suggested organization for operation of a demonstration farm is shown on Plate 10.

The initial step required for establishing a demonstration farm is a survey and analysis of the resources of each of the farms to be organized. Proper interpretation of such data forms the foundation upon which a farm plan is built. Farm plans take into consideration all the factors affecting agriculture. Among these are soil quality in terms of physical and chemical characteristics, slope, cover, soil erodability,

PLATE NO. 10

DEMONSTRATION FARM—ORGANIZATIONAL CHART


Administration
Manager
K600/month
Operations
Servicing
Assistant Manager
K350/month
Trainee
Trainee
Skilled labor
K150/month
Trainee
Trainee
Skilled labor
K150/month
Trainee
Trainee
Skilled labor
K150/month
Trainee
Trainee
Trainee

topography and drainage. The climate is considered with respect to intensities of temperature and rainfall. The aims of the individual farms are kept in mind while preparing the farm plan. The final plan shows the types of crops that should be grown, the cultivation method and machinery to be used, the crop rotations to be followed, the areas to be grazed indicating the grazing period and number of livestock, the soil conservation practices that should be adopted, the particulars of using irrigation water, and a host of other advisory matters. The farm plan should include a complete cost estimate for both capital investment required and operating costs. The preparation of the five farm plans should be the responsibility of an agronomist of experience similar to that obtained in the Soil Conservation Service of the United States, and should not require more than six to nine months.

Among foreign personnel to be employed the most important and useful individuals would be the practical farmers to organize and operate the farms in the initial period. These farmers should work closely with their Burmese counterparts and should be released as soon as training was found to be adequate. As a continuous farming program extends over several years, new problems would develop. An experienced farmer, retained after completion of a relatively short teaching period on the farm, could serve as a farm consultant for a year or longer. Probably three or four foreign farmers could satisfactorily establish the proposed five demonstration farms. After an 18-month or 2-year period, their numbers could be reduced to one or two, acting as advisors.

A few qualified foreign farm mechanics could also do much toward establishing and maintaining a successful program of mechanized farming. Each of the demonstration farms should be equipped to handle all echelons of repair for all equipment on the farm. A program of such scope requires the services of an experienced, practical mechanic to organize and train a cadre of service personnel. The overstaffing program suggested for demonstration farms would permit the training of sufficient personnel to serve several such farming units. One foreign mechanic per demonstration farm for a two-year period would be sufficient not only to maintain farm equipment on the demonstration farms, but to train a cadre of 30 to 50 Burmese mechanics to carry out the same program on as many farms.

The use of foreign personnel in establishing demonstration farms would serve principally to catalyze the broad changes sought in farming methods. It is not to be expected that farming in Burma should follow an exact pattern of that in any other country. The adaptations that Burma would necessarily make in instituting changes could be worked out in the demonstration farms. Foreign personnel can only suggest methods that have been successful in other parts of the world under conditions essentially similar. The burden of implementation lies with the Burman.

e. Cost Estimate

The following cost estimate for establishing a demonstration farm in the vicinity of Yamethin is considered typical. It is expected that the farm would cover 500 acres and would be engaged in producing the usual variety of agricultural products common in the area. The farm plan would include a diversification of crops with two rotations consisting of green manure, cotton, pulses and sesamum ; and forage grasses, corn, pulses and wheat. Rotations would cover a two-year period and provide for livestock fattening during a portion of that period.

The cost estimate is separated into labor, machinery maintenance, improvement and other costs. The cost of foreign personnel necessary for organizing the first demonstration farms should not be a cost charged against the demonstration farms proper and is therefore not included in operation costs. Trainee labor likewise is not charged to costs of demonstration farms.

f. Returns

Table VIII–14 (*see next page*) summarizes the costs and expected returns from a typical demonstration farm operation based upon the cultivation of 500 acres under an irrigated, double-cropping program. Costs and benefits have been calculated on a per-crop basis, and should be doubled for determination of annual values. It is seen that the cost per crop is approximately K74·0. Returns approach K102·5 per acre leaving a profit of K28·4 per acre per crop. Thus annual profits would accrue at the rate of K56.87 per acre per year. Indirect values of soil improvement are not taken into account in the calculation of benefits.

4. RESEARCH AND EXTENSION

a. Government Plans and Organization

A research and extension system has been functioning for many years under the Department of Agriculture. Valuable work has been performed, particularly in the field of plant breeding and development of improved crop varieties, but the work has been of modest scale. Many methods successful in other countries have not been tried in Burma.

(1) Present Organization

The present organization of research and extension work in Burma is outlined on the charts, Plates 11, 11A, 11B and 11C. This organization has been handicapped by its limited staff which has

TABLE VIII – 14

DEMONSTRATION FARM COST AND RETURN ANALYSIS (PER CROP)

(Farm level)

Type	*No.*	*Unit*	*Cost*	*D. Rate*	*D. Cost*	*6% Int.*	*Maint.*	*Cost/Acre*	*Cost/Acre*
Labor	⅓	Manager*	K600/Mo.	—	—	—	—	K2.40	
	⅓	Asst. Mgr.*	350/Mo.	—	—	—	—	1.40	
	3	Skilled Labor	150/Mo.	—	—	—	—	5.40	9.20
Machinery	2	Tractors	29,800	8	1,860	894	5,000	15.50	
	2	Plows	5,500	5	550	166	55	1.54	
	2	Harrows	3,880	5	388	118	39	1.09	
	2	Mid. Brkvs.	9,800	5	980	294	98	2.77	
	1	Border Harrow	4,130	5	413	124	41	1.15	
	1	Duster	3,000	5	300	90	30	0.84	
	1	Separator	17,600	8	1,100	528	110	3.47	
	1	Binder	8,300	8	515	250	52	1.63	
	1	Maize Picker	7,970	8	500	238	50	3.15	
	1	Drill	4,030	5	403	121	40	1.13	32.27
Maintenance	All Equipment		7,000	10	350	210	35	1.19	1.19
Improvements	⅓	Mgr. House	6,000	10	100	60	10	0.34	
	1	Labor House	9,000	10	150	90	15	0.51	
	1	Shop	5,000	5	500	150	50	1.40	
	1	Equip. Shed	5,000	5	500	150	50	1.40	
	1	Granary	10,000	15	333	300	33	1.33	
	1	Feed Lot	2,000	5	200	60	20	0.56	5.54
Other	1	Lot Fert.	15,600	—	—	—	—	23.20	
	1	Lot Seeds	645	—	—	—	—	2.58	25.78
								Total Cost per Acre	K73.98

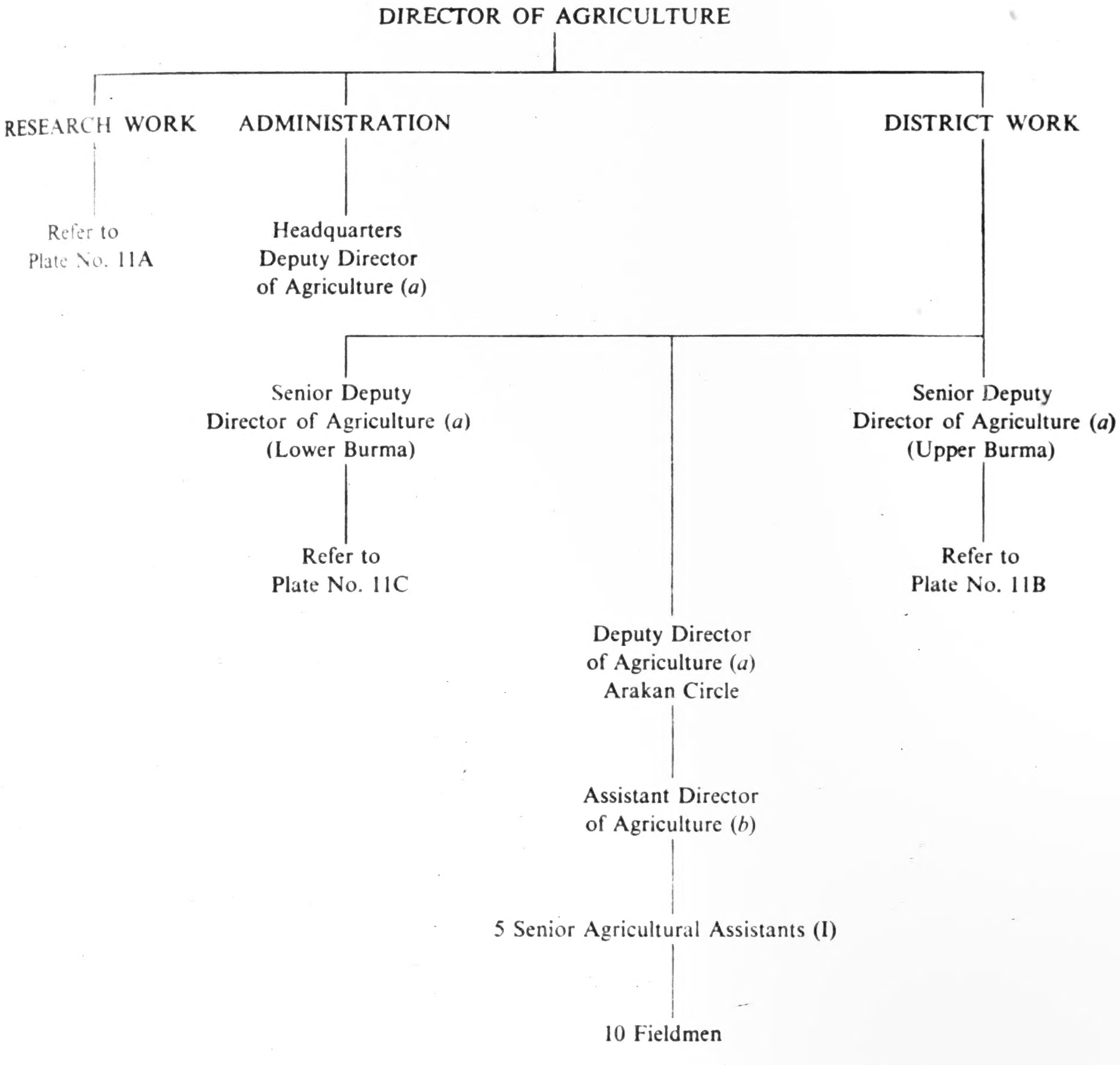
RETURN

Crop	*Acres*	*Value*	*Cultivation Cost*	*Profit*
All	500	K51,208†	K36,990	K14,218
			Total Profit per Acre	K56.87

*Works on three farms. †Based on value of crop production on 375 acres and green manuring plus grazing values on 125 acres.

PLATE NO. 11

PRESENT ORGANIZATION OF THE AGRICULTURAL DEPARTMENT


DIRECTOR OF AGRICULTURE
RESEARCH WORK
ADMINISTRATION
DISTRICT WORK
Refer to Plate No. 11A
Headquarters Deputy Director of Agriculture (*a*)
Senior Deputy Director of Agriculture (*a*) (Lower Burma)
Senior Deputy Director of Agriculture (*a*) (Upper Burma)
Refer to Plate No. 11C
Refer to Plate No. 11B
Deputy Director of Agriculture (*a*) Arakan Circle
Assistant Director of Agriculture (*b*)
5 Senior Agricultural Assistants (I)
10 Fieldmen

Note: (*a*) indicates Selection Grade Service.
(*b*) indicates Senior Branch of the Burma Agricultural Service.
(*c*) indicates Junior Branch of the Burma Agricultural Service.
The figures indicate the number of posts. Where no figures are shown the posts are single.

PLATE NO. 11A

PRESENT ORGANIZATION OF THE AGRICULTURAL DEPARTMENT

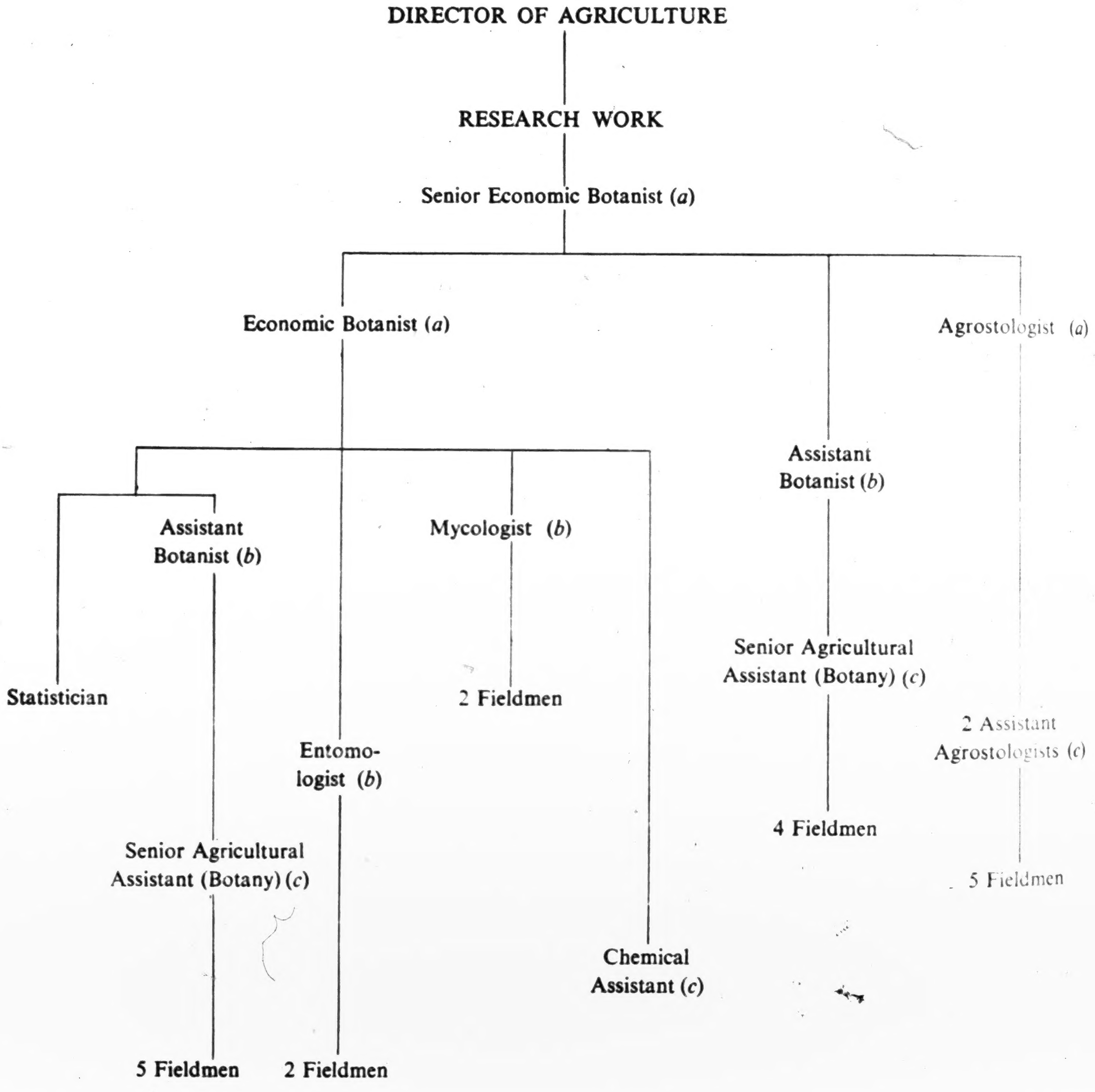
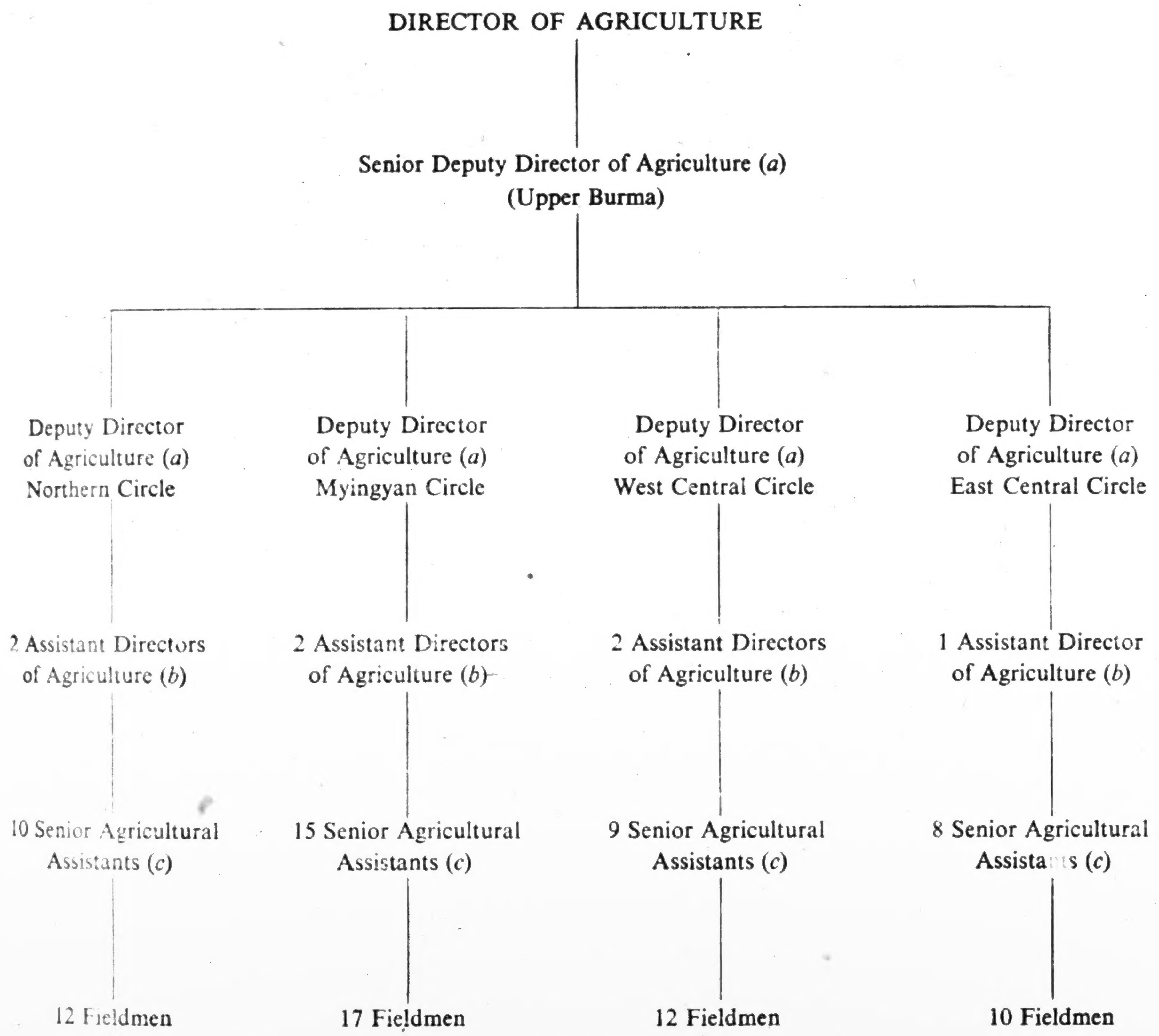

DIRECTOR OF AGRICULTURE
RESEARCH WORK
Senior Economic Botanist (*a*)
Economic Botanist (*a*)
Agrostologist (*a*)
Assistant Botanist (*b*)
Assistant Botanist (*b*)
Mycologist (*b*)
Senior Agricultural Assistant (Botany) (*c*)
Statistician
2 Fieldmen
2 Assistant Agrostologists (*c*)
Entomologist (*b*)
4 Fieldmen
Senior Agricultural Assistant (Botany) (*c*)
5 Fieldmen
Chemical Assistant (*c*)
5 Fieldmen
2 Fieldmen

PLATE NO. 11B

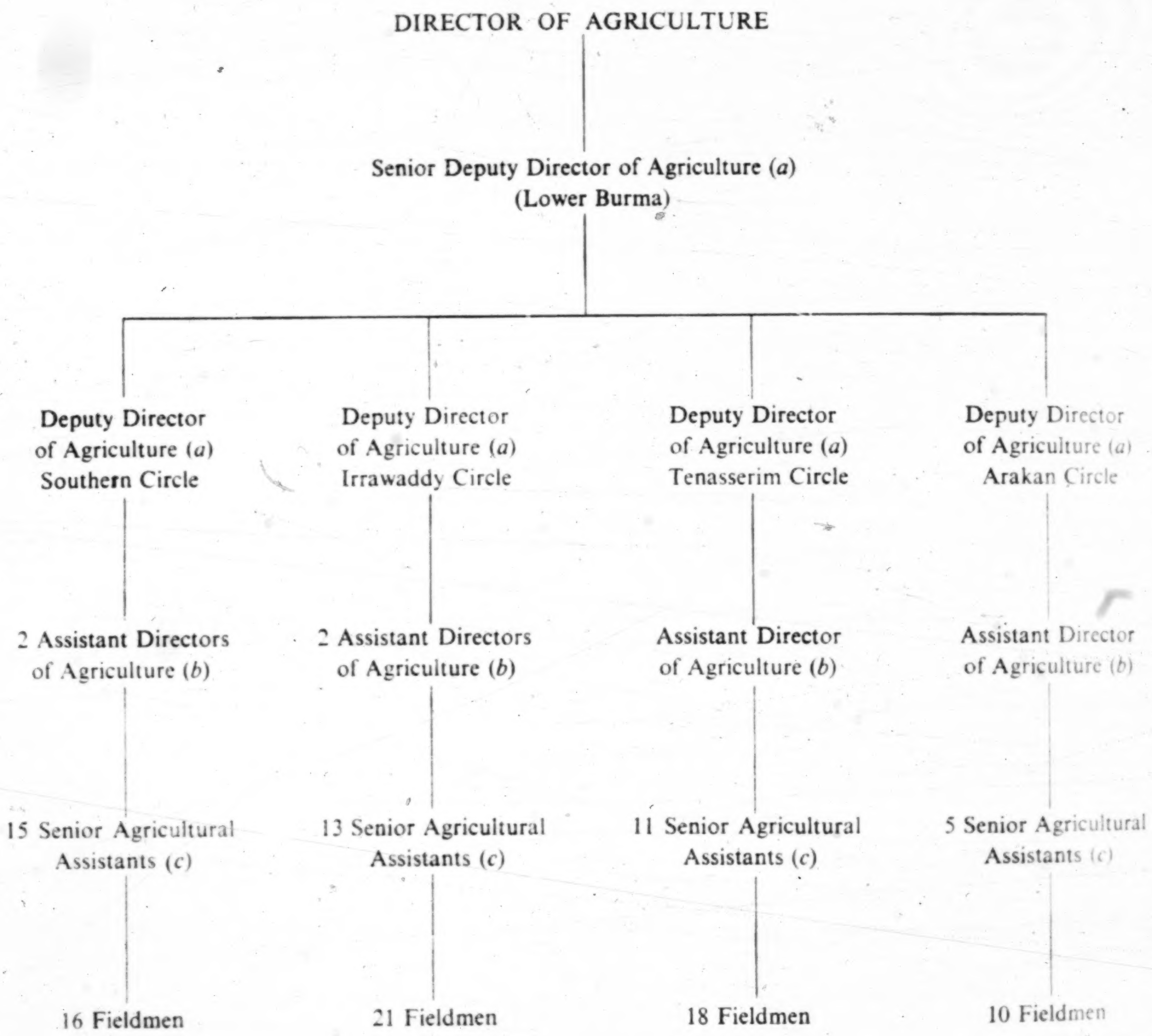
PRESENT ORGANIZATION OF THE AGRICULTURAL DEPARTMENT


DIRECTOR OF AGRICULTURE
Senior Deputy Director of Agriculture (*a*) (Upper Burma)
Deputy Director of Agriculture (*a*) Northern Circle
Deputy Director of Agriculture (*a*) Myingyan Circle
Deputy Director of Agriculture (*a*) West Central Circle
Deputy Director of Agriculture (*a*) East Central Circle
2 Assistant Directors of Agriculture (*b*)
2 Assistant Directors of Agriculture (*b*)
2 Assistant Directors of Agriculture (*b*)
1 Assistant Director of Agriculture (*b*)
10 Senior Agricultural Assistants (*c*)
15 Senior Agricultural Assistants (*c*)
9 Senior Agricultural Assistants (*c*)
8 Senior Agricultural Assistants (*c*)
12 Fieldmen
17 Fieldmen
12 Fieldmen
10 Fieldmen

it needs more da

PLATE NO. 11C

PRESENT ORGANIZATION OF THE AGRICULTURAL DEPARTMENT


DIRECTOR OF AGRICULTURE
Senior Deputy Director of Agriculture (*a*) (Lower Burma)
Deputy Director of Agriculture (*a*) Southern Circle
Deputy Director of Agriculture (*a*) Irrawaddy Circle
Deputy Director of Agriculture (*a*) Tenasserim Circle
Deputy Director of Agriculture (*a*) Arakan Circle
2 Assistant Directors of Agriculture (*b*)
2 Assistant Directors of Agriculture (*b*)
Assistant Director of Agriculture (*b*)
Assistant Director of Agriculture (*b*)
15 Senior Agricultural Assistants (*c*)
13 Senior Agricultural Assistants (*c*)
11 Senior Agricultural Assistants (*c*)
5 Senior Agricultural Assistants (*c*)
16 Fieldmen
21 Fieldmen
18 Fieldmen
10 Fieldmen

attempted to spread its influence over too wide an area. It has therefore been unable to work closely enough with the cultivators to win their confidence. The average extension worker can spend only about 50% of his time in the field. Much of this time is spent in travel to and from villages. He is usually responsible for about 300 villages but normally can visit only about seven to eight a month. The result is that normally any one village does not see the extension worker more than two or three times a year and many do not see him at all. In a few areas where extension workers have been able to concentrate their efforts the results have been very good. Shangalay Kyun village near Mandalay offers an excellent example of what can be done. The introduction of Virginia tobacco by the Agriculture Department has raised incomes substantially and provided off-season employment to the villagers.

The field worker is further handicapped by the need not only to divide his time between research and extension but also to care for service activities and routine administrative details. In addition to his responsibilities in the extension field he is now responsible for distribution of seed, equipment and fertilizer, supervision of custom plowing, supervision of major and minor seed farms and maintenance of proper accounts for each of these activities. This does not leave him enough time for extension activities.

(2) Agriculture Department

An excellent plan for the expansion and reorganization of the Agriculture Department prepared in 1949 and subsequently modified is still under consideration. A report by the STEM Adviser on extension also gives detailed recommendations for expansion of extension which are in general consistent with the plan of the Agriculture Department (Plate 12). Immediate steps should be taken to implement this plan.

The plan for reorganization of the Agriculture Department calls for a village worker for every five village tracts, a supervisor for every five village workers, a township agricultural officer for each township and a district agricultural officer for each district. This will mean that present senior agricultural assistants will be filling district posts and that new graduates from Mandalay College will also be entering the service at that level. Present fieldmen will be taking jobs as supervisors or township officers. Graduates of the central farm schools, the agricultural training institute, and vocational high schools will be used to fill the remaining posts.

(3) Extension

Training in extension methods has been neglected in the past and should be instituted immediately. In-service training consisting of short training courses at various district and circle conferences of extension workers can be started immediately. A manual of extension methods should be prepared for use as a practical guide for extension workers. Courses in extension methods should be provided at Mandalay College, the Agricultural Training Institute, and the Central Farm School.

b. Diversification of Research

The needs of agriculture in Burma are more critical in some directions than others. Research could contribute to the long-range satisfaction of these needs. Specific emphasis should be given to the introduction of new crops, improving seed other than paddy, an investigation of trace element deficiencies in soils, and the establishment of the necessary library and laboratory facilities.

(1) Agronomy

The soil and climatic conditions peculiar to Burma present a research challenge to introduce or develop suitable alternative crops for the delta regions. Successful alternative crops, whether producing agricultural commodities or green manure grazing benefits, would render the region much more productive. Increased production also would be of improved quality due to better soil management. Proposed pump irrigation of certain delta areas would permit production in the dry season. An intensification of present paddy monoculture would contribute to a decline in soil productivity with consequent problems. The introduction of suitable second crops that could withstand moderate salinity and grow on stiff clays typical of the Delta appears worthy of research consideration.

Second crops for paddy soils would permit programs of crop rotation. Research in crop rotations would naturally follow the introduction of second crops. Rotations involve using soil to produce crops that sometimes offer no direct return to the cultivator. In other instances it is impractical to utilize the grazing value of green manure legumes. The solution of one problem often creates several new ones as research leads progressively toward better soil utilization. The abundance of a forage crop grown essentially for soil improvement purposes would require research into the possibilities of livestock fattening during certain seasons and possibly the feeding of dairy stock. Conditions for livestock on the Delta are not ideal and research in that field would be necessary before an action program could be initiated. The introduction of new crops and varietal improvement of those now produced is a research problem that extends to all parts of the country. It is more critical in the Delta and, conversely, more applicable in the Dry Zone where growing conditions are less extreme.

PLAT

PROPOSED EXPANSION O

DIRECTOR O

DIRECTOR O

DEPUTY DIRECTOR O

Lower Burma

Divisions	*Agronomy*	*Agriculture, Chemistry and Soils*	*Entomology*	*Plant Pathology*	*Animal Industry*	*Agricultural Engineering*	*Rural Economics*
Class I	Agronomist	Chemist	Entomologist	Plant Pathologist	Dairyman	Agricultural Engineer	Economist
Class II	3 Deputy Agronomists	1 Deputy Chemist	5 Deputy Entomologists	1 Deputy Pathologist	1 Deputy Dairyman	1 Deputy Agricultural Engineer	4 Deputy Economists
Class III	8 Assistant Agronomists	3 Assistant Chemists	10 Assistant Entomologists	2 Assistant Pathologists	3 Assistant Dairymen	1 Assistant Agricultural Engineer	8 Assistant Economists
Laborers or Clerks	16 Fieldmen	3 Fieldmen	9 Fieldmen	2 Fieldmen	6 Fieldmen	2 Mechanics 2 Assistant Mechanics 6 Artisans	8 Clerks

*This diagram shows only the personnel for research in agricultural engineering and entomolog

NO. 12

AGRICULTURAL RESEARCH*

AGRICULTURE

AGRICULTURAL RESEARCH

AGRICULTURAL RESEARCH

Upper Burma

Fresh-water Fisheries	*Library*	*Agronomy*	*Chemistry*	*Entomology*	*Plant Pathology*	*Agricultural Engineering*	*Library*	*Total*
Biologist		Agronomist						9
1 Deputy Biologist	1 Deputy Librarian	4 Deputy Agronomists	1 Deputy Chemist	1 Deputy Entomologist	1 Deputy Plant Pathologist	1 Deputy Agricultural Engineer	1 Deputy Librarian	27
1 Assistant Biologist		8 Assistant Agronomists	2 Assistant Chemists	4 Assistant Entomologists	1 Assistant Plant Pathologist	1 Assistant Agricultural Engineer		52
4 Fieldmen	1 Clerk	16 Fieldmen	3 Fieldmen	4 Fieldmen	1 Fieldman	2 Mechanics 2 Assistant Mechanics 6 Artisans	1 Clerk	94

The staff required for the custom work is shown separately under departmental setup.

The Shan State, parts of northern Burma, and the Yoma areas generally are characterized by Taungya agriculture. The custom of clearing forested slopes for a two- to four-year period of cultivation leaves these areas open to rapid soil erosion. Such hillside cultivation is traditional, and was probably originally motivated in part by the relatively lesser incidence of malaria in the hills as compared to the valleys. Taungya cultivation is destructive of soil beyond forseeable repair or feasible reclamation. The volume and seriousness of the problem multiply with its extension. Research could provide a factual background for the problem and would possibly yield methods of hillside agriculture without soil erosion. The erosion of lesser slopes is a relatively minor problem and is probably related to the usual disregard of basic tenets of soil conservation such as contour cultivation, regulated grazing and others. The bund construction on soils producing paddy is ideally suited to the ends of soil conservation, and bunded valleys are seen extending into rather steep slopes.

The methods of soil management are devoted presently to production under primitive conditions. Increased agricultural output will come from intensification of cultivation. Such intensification will result from the use of improved seed, fertilizer, mechanization and irrigation. The greatest benefits at lowest cost are those associated with advanced farming techniques. The major research emphasis therefore should be placed in favor of that type of agricultural development. Agronomically, the use of natural and chemical fertilizers, and the use of improved seed offer a wide field for investigation.

(a) Introduction of new crops. Among food and oil crops, it is believed that soy beans, safflower, and the castor plant merit special consideration. Soy beans have been planted in Burma without good results but should have further study. The castor plant is seen rather abundantly in the Dry Zone, growing wild. These two, and safflower, are capable of good yields of oil under satisfactory growing conditions in other parts of the world and should be well adapted to the climate in the Dry Zone of Burma. An intensive program of soy bean variety introduction would yield at least a more satisfactory soy bean than has been grown so far in Burma. Safflower is a heavy yielding oil plant, the refined products of which are used principally in the paint industry. Climatic conditions would seem to justify its trial introduction. The castor plant, a well-known medicinal, is finding a new market in the lubrication field. Research workers in Venezuela have developed a spineless or near spineless castor plant variety that maintains an ample yield of oil. The growing conditions in the Dry Zone appear to be favorable for production of this crop and it might be considered for introduction in an area of ample labor supply for picking the beans.

The classification of soils for the Yamethin irrigation project revealed that large tracts of Grade III soils (see p. 181) extend over that portion of the project lying within the Dry Zone. Some of these soils, and probably many other areas of Burma, are believed to be suitable for sisal production. As a new fiber crop, sisal might yield products useful for cottage industries and, with a little care, make otherwise relatively unproductive land useful. Attempts to produce jute in Burma have not been very successful, but careful testing might indicate the way to better results and should precede any large-scale planting of jute. The close competition of jute with better rice lands, and the considerable hand labor that necessarily enters into jute production are deterrent factors.

The legumes currently produced in Burma are all food or cash crops. The variety is large, indicating that growing conditions are generally good for leguminous plants. The value of such legumes as kudzu, alfalfa, lespedeza and the clovers has never been fully exploited in Burmese agriculture. Such legumes are beneficial as soil improvement crops, particularly in consideration of the grazing benefit that is possible at the same time. It is believed that the introduction of leguminous crops, principally as soil improvement measures, should be given careful testing particularly in the dry zone area. The successful introduction of the legumes mentioned, or of any others serving the same purposes, would have a considerable influence in promoting a diversification of agriculture. Forage legumes, seeded in a mixture of pasture grasses, serve a dual purpose in providing excellent grazing and in improving the soil, largely through the activity of nitrogen-fixing bacteria parasitizing the roots of the host legumes. Legumes need not be confined to second-class or marginal soil, as the production potential of some, such as alfalfa, is sufficiently large to justify production on Grade I soil, under irrigation. The introduction of some legumes into Burma is restricted by conditions of climate, particularly those relating to the peculiarities of photoperiodism associated with temperate varieties of alfalfa, ladino clover, and others. Recent work in the development of leguminous forage and soil-improvement crops in Puerto Rico and elsewhere has yielded varieties of "tropical" alfalfa and kudzu that might be suitable for the climatic conditions of Burma.

The grazing requirements of Burma have never been large and, in the near absence of dairy and livestock industries, grazing management has not been forced into full utilization of unimproved grazing resources. The major problem occurs in the Dry Zone where, in the dry season, insufficient forage is available and cattle must be fed. A future field of investigation might be the introduction of forage grasses both for range and pasture lands. Planted with legumes, forage grasses provide both grazing and green manure benefits on cultivated land.

(b) **Improved seed other than paddy.** The emphasis on seed improvement has always been given to paddy, almost to the exclusion of other crops. It is believed that many crops are deserving of attention for development of new varieties to fit the peculiar climatic conditions in Burma. Preference should be given to the improvement of those crops in which the country is trying to become self-sufficient. Principal among these are the oleaginous crops, sesamum and groundnut. The several hundred varieties of sesamum give an indication, by their abundance, of the almost infinite genetic variation that is characteristic of the plant. Outstanding work in the field of sesamum varietal development has been carried out in Venezuela, the results of which have increased yields to an average of 600–800 pounds and more per acre. The very low yields of sesamum in Burma, averaging around 117 pounds per acre, may be due to conditions not altogether related to seed variety. A deficiency of trace elements, discussed elsewhere, or cropping methods including water availability, could contribute to the general low yield. All factors that might depress yields require investigation, and careful attention should be given to seed improvement.

Groundnut improvement should begin only after a thorough program of introduction of exotic varieties is completed. Recent work in the United States has produced a new variety of groundnut that yields a hay crop instead of nuts. From Central America it is reported that a new variety has been developed that is practically resistant to leaf-spot fungus (*Cercospora spp.*). The most productive groundnut varieties are those of the Spanish type. They are characterized by having a bunch type growth which permits easy cultivation and harvesting, small nuts and a high oil content. Aside from possibly using a hay type groundnut as a pasture mixture, the principal goal in groundnut improvement should be in the oil production possibilities. Spanish varieties of groundnut are best able to provide the basic stock of genetic improvement for that crop.

(2) Entomology

The essential first field of research investigation in entomology should be classification of the indigenous insect population. Following the separation of insects into those destructive, those useful, and those that lie between the two extremes, studies should be made on insect pests most damaging in their activities. It is believed that Burma suffers little from "invasion" type insect pests such as the locust, although cyclic variations in population norms could create serious problems of a local nature. The paddy crop has not suffered appreciably from insect depredations. Certain other crops have. Probably the most damaging insects in Burma are those attacking stored grain.

Chemical insect-control methods appear to be effective, within narrow limits, in all climates. The numerous nerve-killing compounds developed recently have revolutionized the methods of insect-control application and greatly increased their effect. Treatment costs have decreased considerably. The nature of the new insecticide compounds requires special distribution equipment, usually involving an appreciable investment. However, the equipment is designed for large-scale and low-cost operation. Indeed, the use of advanced chemical insect-control methods is predicated on modern farming practices for the most part. Research in chemical insect-control should be confined to studies of relative toxicity and effect of insecticides under a variety of treatment conditions. Continuing programs of residual insect-control should include studies of resistance development in certain destructive insects. It is believed that any large-scale program of insect control would fall upon the Government to implement. Accordingly, research should include an investigation into the type and variety of application equipment best suited to the needs of Burma.

The control of insects attacking stored grain and other farinaceous products is influenced by several factors. Basic among these is the manner in which grain is stored. Basha godowns or open deposits of bulk or sacked rice are difficult to treat for insect control. Granaries with grain stored in bulk are ideally suited for such treatment. Investigations into treatment methods should be conducted in cooperation with SAMB or other government handling and storage agencies.

(3) Plant Pathology

Infestations of fungus, virus, and other disease organisms are a problem of unknown dimensions in Burma. Paddy is not greatly affected by diseases other than smut. It appears that rust is a serious and perhaps a critical factor controlling the production and yield of wheat in some parts of the country. Research into disease problems should begin with a survey of indigenous disease organisms, concentration areas, and the principal crops attacked.

(4) Agricultural Chemistry and Soils

The near absence of soil information in Burma permits a wide field of activity in soil classification and laboratory work. Unusual climatic and growing conditions in the Delta warrant investigation into the relationships of low pH, reduced soil leaching and reasonably high soil calcium levels. The introduction of new crops into the Delta would create a host of new problems in the management of delta soils, and research in soil chemistry would be essential in guiding the development of that program. Within the scope of agricultural chemistry, trace element deficiency investigations should be made on soils of restricted areas. It might be that large tracts of cultivated acreage are limited in their productivity by a deficiency of trace elements.

(a) Trace element investigations. The role of trace elements in crop nutrition is recognized as an important and sometimes a critical factor affecting agricultural production. In recent years attention has been given to marginal and submarginal lands with investigations aimed toward determining the availability of trace elements. Research work in subtropical areas of the world has indicated that otherwise productive land is practically worthless if one or more of the trace elements are absent or nearly so. Most of the research work has been done on boron, copper, cobalt, zinc, molybdenum and manganese. Very significant results have been forthcoming. In Australia the practical application of corrective measures is currently under way with dramatic success.

Trace elements are those that are usually present in soils, but not contributing major amounts of nutrient salts to growing crops. They are rarely deficient to such a degree as to preclude crop production altogether. Their very low concentration leads to extremely low yields that are considerably out of proportion to the trace element representation in the soil complex. Deficiency symptoms usually occur in the quality of produce before the yield is seriously reduced. Trace element deficiencies appear to be more detrimental in dicotyledenous plants.

A review of the agricultural literature of Burma reveals that an unknown "disease," variously known as shock head, green flowered sesamum, or chinbaung, affects the sesamum crop. The symptoms are poor terminal growth and incomplete differentiation of flower parts. These symptoms suggested a deficiency of one of the trace elements, probably boron.

Boron is usually derived from the decomposition of tourmaline. The form of boron available to plants is largely held in the organic fraction of the soil. If the organic matter of soil is low, a consequent reduction of available boron can be expected. Soil pH values exceeding eight have the tendency to render boron unavailable due to a chemical change that occurs in the soil. Boron concentrations of less than one part per million are considered deficient. The application of very small quantities of sodium borate (Borax), a water-soluble form of boron, on soils containing one part per million or less of boron may have very significant results. However, in excess of 100 ppm, boron may have a depressing effect on agricultural production. Superabundant applications of boron are soil sterilizing in nature, and are often used commercially for that purpose.

Soils in the Yamethin and Pyinmana sub-divisions of Yamethin District have been tested for boron. The results of these tests indicate that boron is generally deficient in the area tested. It is possible that the deficiency is so acute as to be seriously affecting some crops. It is suggested that the malformation characteristics of sesamum are related to boron deficiency. Research can determine what corrective measures are necessary, and whether the deficiency extends to trace elements other than boron.

Investigational work in determining the extent of trace element deficiencies should be restricted to those areas that are suspected of such deficiencies. The conditions conducive to trace element deficiencies are varied, and occur in isolated areas or spread over large tracts of land. Field testing for determining the degree of deficiency and for recommending corrective measures should be closely coordinated with laboratory work.

(b) Establishment of soil analysis laboratory. In line with the determination of trace-element deficiencies, the establishment of a soil analysis laboratory is essential. The planned program of irrigation project construction is necessarily closely tied to land classification. Proper land classification requires laboratory work and, for large-scale programs, a well-equipped soil analysis laboratory is essential. Field kit equipment is very useful and it is believed that all agricultural experiment stations and other field offices should be supplied with equipment of that type.

(5) Animal Industry

This field has not been developed in Burma and no organized livestock production program is functioning. As a new field, investigations should start at the grass roots with a survey and classification of the natural resources that would support such an industry. Those areas apparently best suited to livestock production by reason of climate or potentially abundant feed, namely the Shan States and the Delta, should be investigated first. The survey should cover indigenous and exotic forage plant populations, density and palatability studies. Available supplies for use as supplementary feed, and animal requirements for mineral nutrition in areas of suspected deficiency should be investigated. A cursory survey of livestock pests and diseases prevalent among draft animals might aid the selection of suitable breeds for introduction into the areas concerned. Some breeds of livestock, particularly the typical temperate types of beef and dairy stock, are unable to withstand the high humidity and temperature conditions of the Delta. A common disease, for example, is tuberculosis. Introduction of livestock breeds must necessarily precede attempts to improve them. It is believed that a long-range research program should be started as soon as practicable in order to have a suitable range of livestock breeds available when those areas of agricultural development in the Delta enter the operational stage. After research determines the feasibility of economic livestock production, plans should be laid for investigating the possibilities of processing dairy and other products of the animal industry.

(6) Agricultural Engineering

Burma does not have a single modern farm. Unusual conditions of soil and climate have discouraged the introduction of mechanical farm equipment. The most productive section of the country is the most difficult to convert to mechanized farming owing to the high rainfall, heavy soils, and the like. Dry plowing alone has largely failed. The causes for failure have been due in part to unsuitability of equipment and partially to poor management and lack of research. Mechanized farming, under conditions quite different from those for which most farm equipment was designed, cannot be expected to function efficiently in the hands of untrained personnel. Unsuccessful attempts to use farm machinery in Burma have strengthened the belief of many agriculturists that mechanical equipment is not suitable for this area. In fact, much of agricultural Burma is ideally suited to modern mechanized farming and it is a responsibility of research to investigate and modify farm equipment to that end.

Agricultural engineering should develop methods of farming that are compatible with the use of mechanical equipment. Such problems as folding green manure crops into heavy clays, mechanically harvesting the various paddy-variety crops, the adaptation of grain separators to handle a wide variety of crops, and the seeding of paddy using mechanical equipment, offer challenges to research. By determining power and equipment types best suited to farming conditions it would be possible for research to recommend farm unit sizes best adapted to economic utilization using modern equipment.

(7) Agricultural Library

A research program is strongly dependent upon an agricultural library. The collection of all agricultural literature relating to Burma could be assembled into a central library and serve as a nucleus around which a research library could be built. Agricultural research in every part of the world is now many years ahead of practice. However, it does not necessarily follow that every evolutionary step must be taken in solving an agricultural problem. It is often possible to make immediate application of the latest research results. To be aware of the direction and extent of world-wide agricultural research, and to avoid duplicating work already done, it is considered of importance to establish and maintain an active library research center.

c. Extension

The organization of the present extension service is shown on Plates 11, 11A, 11B and 11C, and that of the proposed revision on Plate 12. The proposed organization is an ultimate target to be reached by gradual stages. The cost of the proposed program is given in Table VIII–15.

TABLE VIII – 15

REORGANIZATION OF THE AGRICULTURE DEPARTMENT

	Present Staff		*Proposed Staff*	
	Number	*Cost (kyats)*	*Number*	*Cost (kyats)*
Senior Administrative Post	1	19,200	1	19,200
Other Administrative Posts	—	—	5	76,000
Selection Grade	14	1,68,000	19	2,28,000
Senior Branch	18	1,14,480	78	4,96,080
Junior Branch	98	4,11,600	366	15,24,600
Inspectors	—	—	483	10,72,260
Fieldmen	126	1,91,646	2,759	41,96,439
Clerical and Peon	185	2,83,578	1,132	18,14,056
		11,88,444		94,28,635
Overhead Costs		10,00,000		1,00,00,000
Cost of Materials		10,00,000		1,00,00,000
Total Cost		31,88,444		2,94,28,635

(1) Fields of Coverage

Burmese agriculture may remain primitive over most of its cultivated acreage for several decades. Efforts to extend agricultural knowledge leading toward the introduction of improved practices should be devoted to primitive agriculture in proportion to its contribution to national welfare. It appears that lack of knowledge about credit, taxes, standards of quality and marketing are as detrimental to the interests of the farmer as the manner in which he farms. Basic information on soils, crops and farming methods will serve to increase production. The dissemination of information on the care and management of livestock will help to reduce animal losses. An understanding of the services that Agricultural Extension offers will encourage a more active interest among farmers for soliciting advice or technical service, particularly if such service is free of cost. An important field of potential development is that of youth group organization. The present generation of farmers is not likely to change agricultural methods appreciably, regardless of the progaganda to which it is subjected. Long-range extension work will be more effective if efforts are concentrated on youth training.

A program for establishing youth training groups would depend upon local extension officers to implement. The plan is simple. Young members of the farm community are joined into one or more groups, each with a distinctive name. The group is organized into officials and members. Regular meetings are held and agricultural discussions are conducted by the extension officer or other qualified person. Members are encouraged to select farm projects which will be planned by them, with competent help, and executed by them. These projects may cover any one of a number of activities such as hog raising, egg production, vegetable growing, sewing and cooking. The spirit of competition is introduced between members of a single group and between various groups. Accurate project records are kept and periodic reports are given to the group. Youthful expression of sincere enthusiasm for different and better methods of increasing farm production might generate some interest in the agriculturist father. A demonstration of improved production on a peasant farm might serve to encourage the spread of that scope, with the inherent obligation on the part of the participant to do all work associated with his project. The contribution of personal effort toward succeeding, and the spirit of competition, generate the type of youth interest that is conducive to learning. Even though the value of new and better methods is not fully appreciated and adopted by the parent agriculturist, some beneficial effect should be registered.

(2) Means of Implementation

There is a natural resistance by agriculturists to changes in agricultural methods that depart from the traditional customs. Spoken or written propaganda is usually ineffectual with uneducated farmers. It is believed that demonstration is a much more effective means of persuading farmers to adopt new practices for increasing their production. The average farmer is not prepared to travel far or to allow much time to observe demonstrations related to farming. It is necessary, therefore, that small-scale demonstrations be arranged for execution in villages. Such demonstrations are relatively costly, but it is believed that they are more effective per unit of money invested than lectures or pamphlets. Demonstrations should be made not only for educational purposes but to improve practices in common use. The quality of demonstration work is given the test in the field and the farmers observing it will be harsh judges of poor work. At the demonstration level, errors cannot be made without jeopardizing the whole fabric of the extension system. The average farmer believes only what he sees and an effective demonstration is more likely to convince him than any other means of extension. The initial problem of demonstration extension is to generate sufficient interest among local farmers to attend and observe what is to be done. Their attitude can be expected to be critical from the outset because the practice demonstrated is new. The results of demonstrated practices are usually not readily apparent and many require a waiting period as long as a crop season to become significant. All of the qualifications and explained advantages are forgotten by the farmer with the lapse of time, while the disadvantages that the new practice entails are not. Among the many, however, there are usually a few that profit from the demonstration. Those few farmers are, in fact, the core of people that will unconsciously carry the burden of disseminating agricultural knowledge. The extension officer serves only as a catalytic agent. The following list is suggestive of the wide variety of extension practices that can be demonstrated :

Farm Supplements and Their Use
The Storage and Use of Manure
The Use of Chemical Fertilizer
Improved Seed, its Storage, Collection and Use
How to Construct a Granary
Care and Feeding of Animals
The Use of Lime
Irrigation Techniques
Identifying Animal Diseases
Methods of Controlling Insects Attacking Oxen
Farm First Aid
Simple Methods of Laying out Bunds
Contour and Strip Farming
How to Treat Seed for Better Germination
Improved Seeding Methods
Improved Cultivation Methods
Improved Harvesting Methods
Farm By-products as Livestock Feed.

The use of propaganda as a means of agricultural extension increases its effectiveness if it is presented as entertainment. Roving teams that travel from village to village showing color and sound films demonstrating desirable practices cost relatively little and are likely to have some effect. The average small village is without a cinema, and an opportunity to attend a free show that does not interfere with the daily work might appeal to many farmers. Follow-up work by the local extension agent would further aid the introduction of improved farm practices.

After demonstration and training film means are partially accepted by agriculturists, the distribution of simple pamphlets might have some beneficial effect. Later a bimonthly or quarterly agricultural publication might be useful, at least for distribution to extension agents.

Probably the most effective extension of agricultural methods is the efficient operation of a demonstration farm. All the demonstrations of farming are on display every day and all phases of farming are capable of observation. Modern farming would employ few of the simple improvement practices recommended for primitive agriculture. The nature of its revolutionary approach to agricultural production would require that modern farming be explained and demonstrated. Organized tours for the purpose of inspecting demonstration farms would acquaint farmers with possibilities of increasing production.

d. Utilization of Aerial Photographs

The agricultural use of aerial photographs is potentially very great. The size of presently unknown land areas topographically suitable for cultivation, natural boundaries, erosion conditions, drainage basins and possible communication routes can be rapidly determined with a high degree of accuracy. Aerial photographs are an aid to land classification by delineating soil type boundaries of the vegetative cover. They are useful on large areas as well as on tracts as small as 100 acres. Aerial photographs are particularly effective in determining drainage areas, and the characteristics of topography at dam sites and along canal lines. Contour maps can be constructed from stereoscopic analysis of aerial photographs, with a degree of accuracy consistent with ordinary plane table surveys.

Administration of the land subsidy program could be facilitated by using aerial photographs for acreage determinations. In the event that land restoration subsidies become differential payments dependent upon the density and other characteristics of the vegetative cover, aerial photographs would serve as authority for determining into which class of subsidy payment any plot of land would fall.

e. Land Classification

Within the framework of long-range agricultural research, land classification should be given consideration. The objective of such a program would be to classify land according to its basic resources and present conditions with the purpose of directing its use toward obtaining the maximum benefit consistent with economy while managing it as a renewable but destructible resource. Such a land classification would designate areas according to their major suitability for cultivation, watersheds, forest, grazing, wild life or recreation purposes. A land classification recommending general land use should be nation-wide in scope and could form a basis for future legislation dealing with proper land use.

Land classification on a smaller scale is specific in its recommendations and is based upon many local factors that affect the growth of crops. Such land classification is justified principally for irrigated soils, and for new areas that have never been cultivated.

Nation-wide land classification on a reconnaissance scale and more detailed technical classification of highly productive soils merits careful consideration as a relatively low cost means of assessing the agricultural resources of the nation and of indicating the best methods for utilizing agricultural soils. The succeeding paragraphs are a condensed presentation of applicable principles and practices of land classification.

(1) General procedure. The normal procedure in soil classification begins with a field reconnaissance of the area to be classified. Aerial photographs or other available reference maps are marked to indentify outstanding land features or characteristics that have a bearing upon classification. A general classification of soils is sketched on the map to show gross differences of soil types, distinctions in topography, drainage characteristics, widely varied natural vegetation, and other factors bearing upon classification. The locations of sites for taking soil samples are tentatively selected. Occasional pits are opened for examination of the surface and subsoil layers. Simple field tests are often made for the determination of pH, relative calcium concentration, or other basic soil conditions.

Data accumulated in the field survey are organized and assembled systematically. The geology of the area is determined. A topographic map with a contour interval of five feet or less is obtained, usually from aerial photographs. If the area to be classified is virgin land, the character and diversity of cover is determined. All data are assembled into a rough soil map from which site selections are made for collecting soil samples.

(2) Sampling. Land classification appraisers enter the field equipped to perform the tests outlined in succeeding paragraphs. The equipment should include such items as base maps, plane table, compass, hand level, shovels, soil augers, sample containers, electrolytic bridge and accessory utensils, and soil reaction (pH) test kit. Aerial photographs provide the best possible base maps. Soil samples are taken at intervals that are determined by the complexity of the soil types over the area concerned. Usually a sample is taken from every 100 to 300 acres. The degree of accuracy required for classification may influence the number of samples taken. A soil auger of three- or four-inch diameter is used to take samples. The upper few inches of soil are removed in order to gather samples of mineral soil free of surface detritus. At one-foot or eighteen-inch intervals a three- or four-pound soil sample is collected to a depth of five or more feet. The samples are placed in canvas bags and marked for identification.

(3) Analyses. In the laboratory, soil samples are tested for chemical and physical characteristics. Determinations of the quantities of total nitrogen, available phosphoric acid, and available potash are expressed in pounds per acre. The per cent of soil organic matter is measured. The soil pH, indicating the hydrogen ion concentration of the soil, is determined and numerically expressed. A pH value of 7·0 is neutral. Values less than seven are acidic in reaction while those exceeding seven are alkaline. A difference of 1·0 in pH values indicates a soil reaction difference ten times greater. Thus a soil pH of 4·5 is ten times more acid than one of 5·5, and 100 times more acid than pH 6·5. Other chemical tests measure the presence of toxic concentrations of sodium in its water-soluble and exchangeable forms, and of calcium carbonate and chlorine. The total concentration of salts is determined by an electric conductivity test. In addition, the base exchange capacity of the soil is measured. There are further chemical tests that may be helpful in soil classification. Those include trace element and minor element determinations, principal among them being boron, copper, cobalt, zinc, molybdenum, iron and manganese.

The physical analysis determines textural and water-relation characteristics of soil. Texturally the soil is graded into particle sizes. Particles having a diameter exceeding 2·0 mm are considered as gravel; from 2·0 mm to 0·2 mm coarse sand; from 0·2 mm to 0·02 mm fine sand; from 0·02 mm to 0·002 mm silt; and particles smaller than 0·002 mm as clay. After determining the per cent representation of sand, silt and clay, a textural class is assigned the sample. Variations in textural class range from sand composed of coarse particles to clay composed of extremely fine particles. It is generally considered that sandy loam, loam, and silty loam constitute the best textural classes. Loams with a preponderance of sand, silt or clay are next in order of textural quality, decreasing in desirability as the major fractions become finer. As extreme conditions are approached soil textural quality is lowered proportionally as sand or clay increase greatly in quantity.

The classification of soils to be irrigated requires the determination of soil moisture equivalent which is approximately the amount of water required to saturate a soil from an air dry condition. Usable water capacity measurements are taken to ascertain the mm of water per meter that a soil can hold and use.

(4) Classification. The field and laboratory data are assembled into several broad characteristics relating to soil classification. These are sometimes separated into four groups, namely soil profile characteristics, those of surface soil texture, slope and other conditions. The soil profile considers the kind of parent rock material from which the soil has been derived, as well as its age and degree of weathering. Note is made of whether the soil is of primary formation or whether it has been laid down as a secondary deposit. The permeability of both surface and subsoil layers is considered, particularly for soils to be irrigated. These characteristics are given numerical ratings decreasing from an optimum condition of 100 to those of 50 or less according to their degree of unsuitability. The average of ratings is then taken as a numerical rating of soil profile characteristics. Surface texture is an important factor in classification and relative values are given to each of the textural classes. In areas to be irrigated, slope is a major consideration with such variations as uniformity, undulation and degree being taken into account.

All other characteristics of the soil are grouped into the last soil characteristic contributing to classification. These factors are generally normal or nearly so. However, any one of them could be a limiting factor or one that by its unfavorable condition could render an area unsuitable for cultivation in its tested condition. The general soil nutrient level is one of these. Particular emphasis is given to total nitrogen, available phosphorus, and available potash quantities, for these are the principal nutrients that are drawn upon heavily by growing plants. The soil pH can be a critical factor. Values under pH 5·5 create conditions conducive to a chemical change in the soil complex that renders certain nutrients unavailable to plants. Phosphorus and magnesium are particularly affected, as are several of the secondary and trace elements. The soil reaction is usually slightly acidic and reactions even of extreme acidity are commonly corrected by lime application. Very high pH values are more difficult to lower. Soil reactions approaching either extreme of the pH scale largely determine crop types that will satisfactorily grow, for every plant has optimum conditions of pH and tolerance limits that are often rather narrow. Soil pH values between six and seven are favorable for most cultivated crops.

The classification of soils to be irrigated takes into account the calcium-magnesium balance in the soil complex, as well as a careful consideration of the total salt concentration of the soil. Sodium salts are given special attention. A consideration of soil drainage is intimately associated with those characteristics. Present erosion and soil erodability are considered, together with characteristics of microrelief. There are other factors peculiar to any particular area that could figure heavily in classification, an example being a serious deficiency of one or more of the trace elements.

The group ratings of each of the broad soil characteristics are then assembled and a final classification is obtained for every soil sample analyzed. Arbitrary values are established for soil grades depending on the degree of intensity desirable in classification and the number of soil grades to be used. The usual soil grade numbers lie between five and eight.

After the classified soil sample locations have been plotted on tracing paper, that information is superimposed on aerial photographs. Soil grade limits are usually easily traced directly from aerial photographs and classified soil sample information. A soil map should show soil sample locations, rivers, cities, canals and other land features of interest.

(5) Classification standards for irrigated land. Five soil grades have been established to fit the needs of agricultural land classification in Burma with due consideration given to the requirements of paddy production. The first three grades are progressively less arable, the fourth is a special or temporary classification. The fifth is a definitely non-arable grade. For irrigated lands or lands to be considered for irrigation, the following classifications are suggested:

Grade I – Arable

Highly suitable for irrigation farming, capable of producing sustained high yields of climatically adapted crops at reasonable cost; smooth lying with gentle slopes; soils deep and of heavy to fairly fine texture; good water-holding capacity; free from accumulations of soluble salts; soil and topographic conditions such that no specific drainage requirements anticipated in the near future, no erosion expected from irrigation, and land development relatively easy.

Grade II – Arable

Moderately suitable for irrigation farming; measurably lower than Grade I in productive capacity; may have lower water-holding capacity, as indicated by light texture or limited soil depth; may require large quantities of irrigation water as indicated by a coarse-textured subsoil. Topographic limitations may include uneven surface requiring moderate costs for leveling. Woody vegetation may have to be removed from the surface. Any one or a combination of these limitations may be sufficient to reduce lands from Grade I to Grade II.

Grade III – Arable

Suitability for irrigation restricted because of more extreme deficiencies in the soil or topographic characteristics as described for Grade II lands. May be more expensive to prepare for irrigation or more costly to farm. May be moderately saline. Adverse potential drainage conditions, correctable at a reasonable cost, may be anticipated. May have good topography, but with inferior soils have restricted crop adaptability; require larger amounts of irrigation water or special irrigation practices, and demand greater fertilization or more intensive soil improvement practices.

Grade IV – Arable

Suitability for irrigation distinctly restricted because of one or more extreme deficiencies in the soil, topographic or drainage characteristics. Soil texture may be very light, restricting the variety of adaptable crops, requiring large amounts of irrigation water or special irrigation practices. May have very uneven topography or restricted drainage, susceptible of correction but at high cost. Included in arable land, but in the irrigable area only after careful consideration or under conditions of an ample water supply.

Grade V – Non-Arable

Steep, rough, broken, or badly eroded; soils of extremely coarse or extremely heavy texture, or shallow soils over gravel, shale, sandstone or hardpan; inadequate drainage and high concentrations of soluble salts.

(6) Specifications for land classification surveys and tests. The accompanying Tables VIII–16 and VIII–17 present typical descriptive specifications for land classification surveys and tests. More detailed specifications and a description of typical soil tests and the laboratory equipment required to make them have been prepared by the Agricultural Section of the Technical Cooperation Administration in Burma.

TABLE VIII – 16

LAND CLASSIFICATION SURVEY REQUIREMENTS

	Reconnaissance	*Semi-detailed*	*Detailed*
Land classes recognized	1–3–5	1–3–5	1–2–3–4–5
Scale of base maps	1 : 24,000	1 : 12,000	1 : 4,800
Accuracy—per cent	75	90	97
Maximum distances between traverse—miles	1	·5	·25
Field progress per man-day—square miles	3–5	1–3	·25
Minimum area of Class 5 to be segregated from larger arable areas—acres	4	·5	·1
Minimum area for change to lower class of arable land—acres	40	10	2
Minimum area for change to higher class of arable land—acres*	40	20	10
Soil and sub-strata examination.† Boring or pits (5 ft. deep) for profile analyses, total salt and pH determinations per square mile	1	4	16
Deep holes (about 15 ft.) for full profile analyses; and permeability studies, mechanical analyses, moisture determinations and chemical analyses of the soil layer—per 50 sq. miles	0	1	2

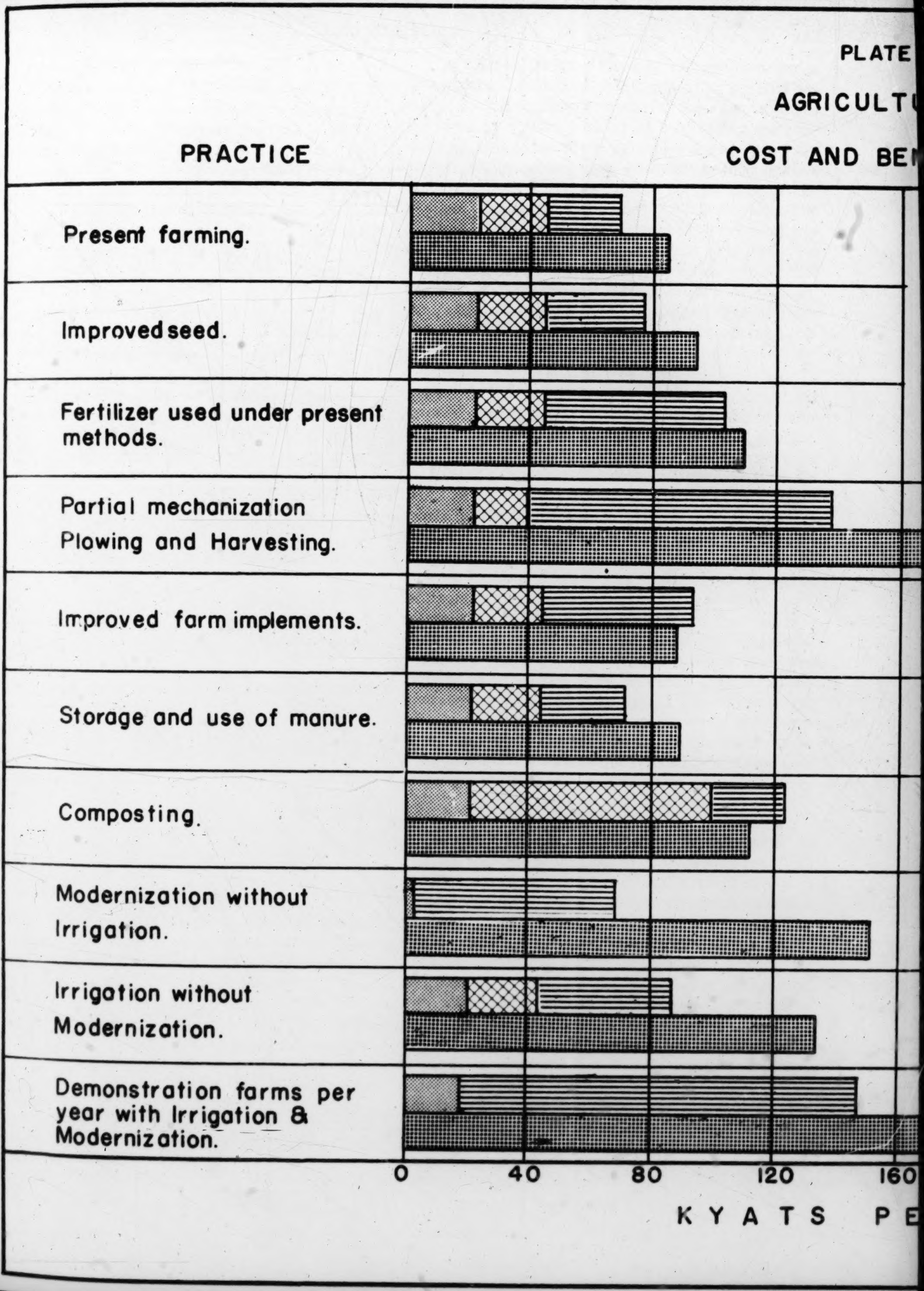
*In addition to size, the tracts must be of such shape and so located as to permit their being farmed as fields.

†The depths indicated are minimum unless impervious material or permanent water table are encountered at shallower depths. The number of examinations and analyses should be increased as necessary to meet specific objectives or with the complexity of the area. Full use should be made also of road cuts, stream banks, and similar exposures.

TABLE VIII - 17

TYPICAL SOIL TESTS

Properties	*Inspection*	*Field Laboratory*	*Complete Laboratory*	*Experimental Plot*
Texture	Observation and "feel" of coarseness, particle size, consistence.	Mechanical analysis of particle size and size distribution by sieve and hydrometer methods.	Mechanical analysis of particle size and size distribution by sieve, hydrometer, and pipette methods.	
Structure	Observation of roct penetration, vegetation, porosity; shape, pattern, and arrangement of particles as criteria of aggregation and porosity.	Volumetric—weight determination of pore size, porosity, pore size distribution. Mechanical analysis of aggregate size, size distribution, aggregation by settling volume procedure. Permeameter measurements of permeability on disturbed and undisturbed samples.	Volumetric—weight determination of pore size, porosity, pore size distribution. Mechanical analysis of aggregate size, size distribution, aggregation by settling volume procedure. Permeameter measurements of permeability on disturbed and undisturbed samples.	
Moisture	Field capacity and permeability estimated by correlations with texture and structure.	Field capacity and permeability from correlations with laboratory determinations of texture. Field capacity and wilting percentage determined by moisture content and moisture tension methods. Permeameter measurements of permeability on disturbed and undisturbed samples.	Field capacity and permeability from correlations with laboratory determinations of texture. Field capacity and wilting percentage determined by moisture content and moisture tension methods. Permeameter measurements of permeability on disturbed and undisturbed samples. Field capacity determined by moisture equivalent centrifuge. Permanent wilting percentage determined by test plant growth.	Field capacity determined by irrigation and sampling for moisture content. Available moisture capacity determined by tensiometer or electrical conductivity in the field plot. Direct tests of infiltration rate. Permeability determined by test holes and shallow wells. Drainage requirement tests.
Chemical	Observations of vegetation and of visible insoluble carbonates and soluble salts.	Salinity determined by wheatstone or conductivity bridge or from conductivity of saturated soil extracts. pH values determined by colorimetric or electrometric methods. Insoluble carbonates determined by dilute acid or acid titration. Gypsum determined by conductivity of acetone extracts. Sodium estimated from pH on dilution.	Soluble and insoluble constituents identified and concentrations determined. Exchange capacity and type of clay mineral. Soluble and exchangeable sodium determined by flame photometer or gravimetric methods. pH of soil suspension determined at CO_2 equilibrium. Fertility and organic matter.	Field tests of amendments for saline—alkali conditions. Physical and chemical effects of water on soil in place. (Note: Experimental plot also used for other studies such as land leveling and effective precipitation.)



PLATE

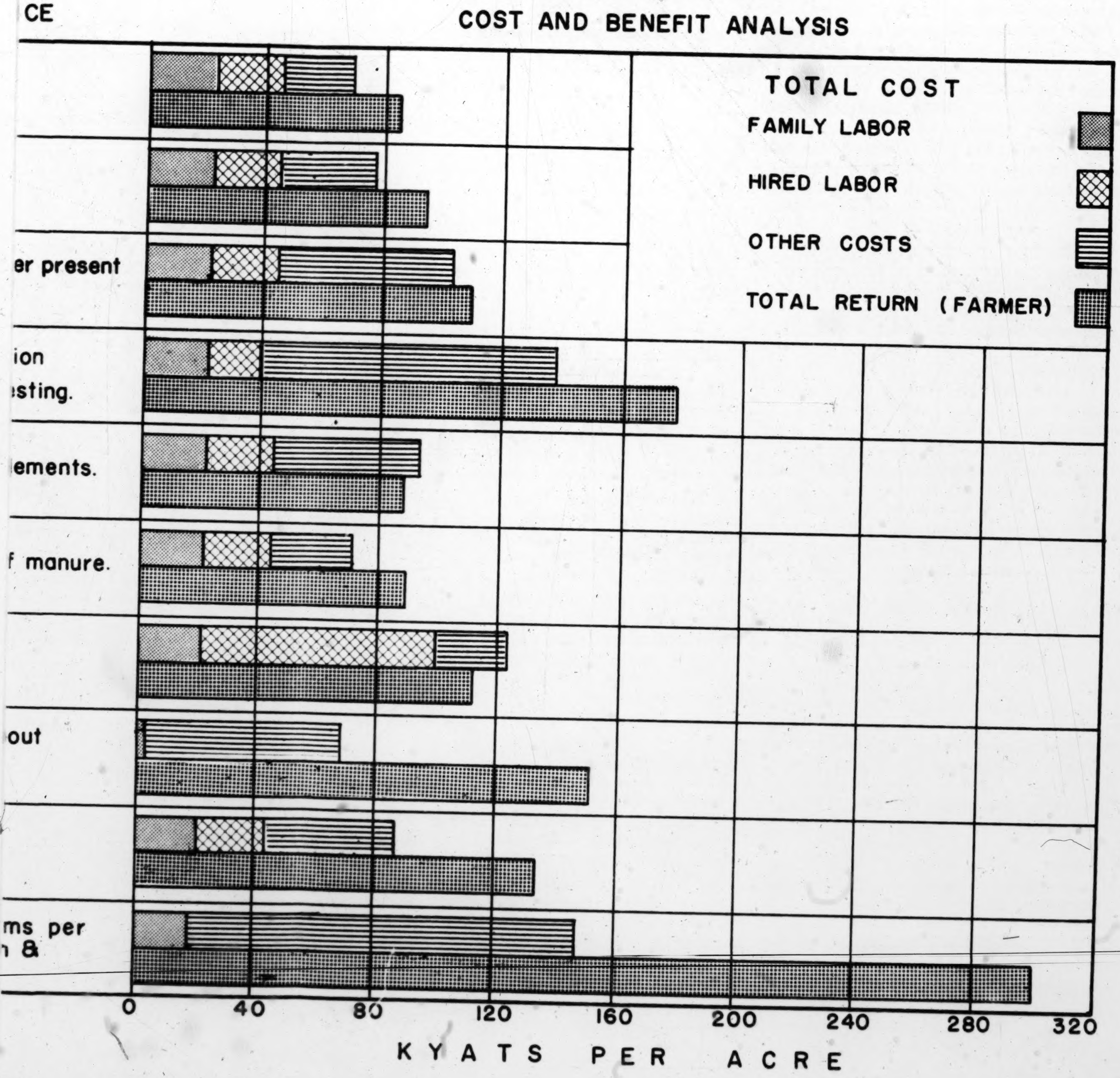
AGRICULT

COST AND BE

PLATE 13

AGRICULTURAL METHOD

COST AND BENEFIT ANALYSIS



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f. Implementation Plan

It is considered essential that effective research, if limited by insufficient funds, should be restricted in its area coverage and complete in its intensity of application. Extension is difficult to effect under ideal conditions. A thinly scattered program that is largely concerned with administrative detail is not effective and probably does not pay to maintain. It is believed that extension should be carried out to the tract level and that most support and emphasis should be given to local extension agents. A reasonably reliable and low cost system of evaluating the effect of the extension program should be established in order to determine its economic feasibility and to direct the program toward those means that are most effective.

A program that would be effective from the outset, a basic qualification, must be modest at the start. Consequently it would be restricted to a limited area. It is believed that the areas most deserving of initial attention are those lying within the proposed irrigation projects. After an effective extension program is functioning in those areas, it could be expanded to other areas of high productive potential and to new areas of undeveloped land resources. Finally such a program could extend itself to all cultivated acreage, expanding only as fast as its effect is economically justified.

5. RESTORATION OF PREWAR ACREAGE

Approximately two million acres of formerly cultivated land are now out of cultivation because of insurgency. It has been found that the re-establishment of government control over these areas is followed by a rapid restoration of cultivation. It is the policy of Government to assist this return to cultivation, and subsidy payments are made to cultivators returning to the land. It appears that no other incentive is necessary to restore formerly cultivated land into productive use, and the problem therefore resolves itself to one of establishing government control over the areas concerned.

6. ANALYSIS OF RELATIVE BENEFITS

Each method employed for increasing agricultural production differs in cost, division of cost between labor and cash expenditure, manner of application and results. The methods for increasing production discussed previously have been cost analyzed and the results detailed in Table VIII–18 (*see next page*) shown graphically in Plate 13. Costs are arranged under major headings such as labor, animals and implements. They have been taken from Table VIII–9 or qualified by footnote reference to other sources. Anticipated returns appear under the specific reason for increased production. In both instances values are expressed in kyats per acre.

The costs of present farming are grouped under labor, animal and implement, and other costs. They reflect both farm and government costs. The values of the costs have been derived by considering the production costs of the major agricultural crops grown in Burma, and weighting them according to their relative representation. The average cultivation cost of the average crop grown amounts to K67.70 per acre. The average total return to the farmer has been similarly calculated, based on 1953 prices at the farm level, and found to be K83.60 per acre. The difference, K15.90 per acre, is the calculated average profit to the farmer. Average present cultivation costs and returns form the foundation of the analysis presented in Table VIII–18.

a. Improved Seed

Under present cultivation methods, the use of improved seed, chemical fertilizer, partial mechanization, improved farm implements, the use of manure, and composting are analyzed. Improved seed is calculated to cost the Government approximately K8 per acre to produce and distribute to issue stations where farmers can obtain it. The cost includes production at standard paddy production costs, plus the cost of transportation and handling. In this instance the average hauling distance was arbitrarily estimated to be from Rangoon to Toungoo. (In addition, consideration was given to the income loss that Government suffers by producing improved seed instead of exporting the production of paddy from the same acreage.) The cost of using improved seed is entirely government borne. The average 10% yield increase is calculated, at present prices, to be worth K8.85 per acre if exported. The total benefit to Government (as distinguished from the farmer) of using improved seed is therefore less than one kyat per acre.

b. Chemical Fertilizer

Chemical fertilizer application is calculated to increase the cost of farming by K33.70 per acre. With a 30% increase in yield, the total average return is K25.08 per acre. Within the present price structure the use of fertilizer is unprofitable for the farmer. The world market price for rice is several times higher than the controlled paddy price within Burma. By controlling the price of paddy, all other agricultural production is automatically controlled relative to paddy. At the farm level, a 30% increase in yield of any crop including paddy is worth less than the cost of fertilizer to produce it if sold at controlled prices. However, if paddy were sold at world market prices, the use of fertilizer would be very profitable. Table VIII–19 (*see p.* 186) indicates the per-acre profit-taking position of farmer and Government in paddy production.

TABLE

AGRICULTURAL METHOD COST AND

(*Based on*

Practice	*Costs to Implement*									
	Labor	*Animals and Imple- ments*	*Produc- tion*	*Trans- portation*	*Distri- bution*	*Pur- chase*	*Mach- inery*	*Con- struction*	*Misc. Costs*	*Total Costs*
Present Farming	43.00	20.80	—	—	—	—	—	—	3.90	67.70*a*
Improved Seed	—	—	8.00*b*	—	—	—	—	—	—	75.70
Fertilizer Use under Present Methods(*d*)	0.50	—	—	1.50	1.50*e*	30.20*f*	—	—	—	101.40
Partial Mechanization, Plowing and Harvesting(*h*)	10.78	—	—	—	—	—	19.56	—	—	136.34*i*
Improved Farm Implements	0.25	24.60	—	—	—	—	—	—	—	92.55
Storage and Use of Manure	—	—	—	—	—	—	—	3.16	—	70.86
Composting	55.60	—	—	—	—	—	—	—		123.30
Modernization(*j*)	2.83	—	—	—	—	—	27.80	—	36.30	66.93
Irrigation	—	—	—	—	—	—	—	19.50	—	87.20
Demonstration Farms Yr.(*r*)	18.40	—	—	—	—	—	64.54	11.08	53.78	147.80

a Weighted nationwide average production = 0·464 tons per acre; weighted value K83.60 per acre; weighted present cultivation cost K67.70 per acre; average net income = K15.90 per acre (Sanders and Table VIII-9).

b Government cost to produce and deliver improved seed.

c Government income by use of improved seed.

d Based on 100 pounds per acre from Rangoon to Toungoo (considered as an average shipping distance).

e Estimated 100% of freight cost, storage, handling and local transportation.

f Based on 10% of 17–45 and 90% of 20-20 chemical fertilizer.

g See separate report analysis.

h If irrigated and double cropped.

i Cost equal to present farming methods except soil preparation and harvesting operation.

VIII – 18

BENEFIT ANALYSIS IN KYATS PER ACRE

1953 prices)

Practice	Expected Returns by Increased Production															
	Soil Preparation	*Fertilizer and Placement*	*Seeding*	*Insect Control*	*Harvesting*	*Cultivation*	*Farming Bunds*	*Green Manuring*	*Crop Rotation*	*Grazing*	*Fallow*	*Abandoned*	*Double Cropping*	*General*	*New Acreage*	***Total Return***
Present Farming	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**83.60**
Improved Seed	—	—	—	—	—	—	—	—	—	—	—	—	—	8.85*c*	—	**92.45**
Fertilizer Use under Present Methods	—	25.08	—	—	—	—	—	—	—	—	—	—	—	—	—	**108.68*g***
Partial Mechanization Plowing and Harvesting	8.36	—	—	—	1.68	—	—	—	—	—	—	—	83.60*h*	—	—	**177.24**
Improved Farm Implements	4.18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**87.78**
Storage and Use of Manure	—	4.55	—	—	—	—	—	—	—	—	—	—	—	—	—	**88.15**
Composting	—	—	—	—	—	—	—	—	—	—	—	—	—	27.90	—	**111.50**
Modernization	4.18	25.10	8.36	6.69	2 51	6.69	8.36*k*	1.50*l*	1.50*l*	1.60*m*	—	—	—	—	—	**150.09**
Irrigation	—	—	—	—	—	—	—	—	—	—	15.05*n*	5.02*o*	—	17.55*p*	12.55*q*	**133.77**
Demonstration Farms	8.36	50.20	16.72	13.38	5.02	13.38	16.72	3.00	3.00	3.20	—	—	83.60	—	—	**300.18**

j See Table VIII–9.

k Estimated that bunds occupy 10% of land.

l Estimated benefit of cost.

m $\frac{1}{10}$ cow per acre for 80 days.

n 18% of present total return.

o 6% of present total return.

p Weighted average increased yield with irrigation is 21%.

q Estimated 15% new land cultivated under any large irrigation program.

r The high labor and machinery costs are based upon a diversified farming program including supervisory personnel necessary for an initial program.

The total benefit from the use of fertilizer, calculating that all excess production would be exported, approximates K28·2 per acre exclusive of costs. The unusual division of profits between Government and farmer has created an economic situation whereby a practice is economically profitable for Government and unprofitable for the grower. The profit to Government is so great that a partial subsidy of the cost of fertilizer seems desirable to permit and encourage chemical fertilizer use. In any case, as the development program is a government program, the criterion for deciding whether or not to introduce an innovation should be the combined profit of farmer and Government, with any injustice to the farmer being eliminated either by subsidy or adjustment of the profit ratios. It would appear under present cultivation methods that fertilizer application would be profitable only for paddy production as that is the only crop that enters the world market.

TABLE VIII – 19

FERTILIZER USE AND BENEFITS (PER ACRE)

	No Fertilizer		*100 lbs. Fertilizer Per Acre*	
	Farmer	*Govt.*	*Farmer*	*Govt.*
Cost of Production or Purchase	K74·4	K84·6	K108.10	K110.00
Value	84·6	161·6*	110.00	223.50
Profit	10·2	87·0	1.90	113.50

*At K146/ton plus SAMB profit of K150/ton = market price of K296/ton or K16·6/acre.

c. Partial Mechanization

Partial mechanization, meaning the mechanization of the soil preparation and threshing operations, is the basis for calculation of double cropping. The farming methods would not change, except for plowing and threshing, and the assumption is made that partial mechanization would be carried out on irrigated land. The cost estimate makes provision for five Farmall Super MD tractors with five 3-disc plows, and a maintenance shop truck to service and repair them. Costs of depreciation, maintenance operation and interest are included in the total costs of plowing. Five tractor operators at K5 per day, one mechanic at K8 per day, and a foreman at K500 per month make up the personnel required. It is estimated that four tractors would work seven hours per day while the fifth is undergoing servicing or repairs. Ten per cent of working time is left for moving operations from one area to another. Threshing teams would be equipped with one thresher and one tractor. Each of the plowing and threshing teams would employ three men and a foreman working independently, and organized and operated as nonprofit cooperatives or government services.

d. Improved Farm Implements

The high initial cost of the tractor, the principal power source for farming operations, entails high depreciation and interest costs which may not be warranted unless the tractor is fully equipped with the less expensive accessories and implements usually provided for soil and crop working and for handling farm chores. The improved implements are therefore to be regarded as particularly important to economical mechanization.

The advantages of using improved animal-drawn equipment are limited to better seed-bed preparation, saving in time, and a lessening of the farmers' physical burden. Oxen for the power, sheds, yokes, carts and animal feed and care would still be necessary. The benefits from such improvements are difficult to evaluate because so much depends on the individual farmer's management and planning, the quality and condition of his animal power, and the amount and kind of equipment being used. In many cases, no essential change in the farming methods may result.

e. Storage and Use of Manure

The storage and use of manure to its fullest potential involves the construction of a storage tank and basin that can protect available manure, both liquid and solid portions, until the time of field application. The depreciation, interest and maintenance costs of such a tank, large enough to accommodate the normal manure output of two oxen for eight months, amounts to K3.16 per acre. The value of the stored manure, in terms of increased yield, is K4.55 per acre. Independent of other modernization measures, the practice is therefore barely profitable.

f. Composting

A cost analysis of composting reveals that at present labor rates and without mechanization measures it is more expensive than the returns resulting from its application. Composting costs are all labor since the constituents of compost are available on the farm—manure, soil and vegetable matter. The analysis was based upon a ten-ton application of compost per acre with an estimated yield increase of 33% per year for a three-year period. Labor of composting was calculated at 66·6 man-days per acre, three-quarters of which was spent handling vegetative material, 10% soil, and 15% manure. The cost of K167 per acre was divided by three to obtain annual per-acre cost at K55·6.

g. Modern Farming

Modern farming was analyzed without irrigation or double cropping. It will be seen at the outset that the total cost is less than that by present cultivation methods and that labor costs are exceptionally low. No labor need be hired. Costs are principally in machinery and equipment, being approximately 18% more than that for animal and equipment under present cultivation methods and for fertilizer. The returns from modern farming are more than twice the per-acre costs, and profits exceed those of present cultivation methods by more than five times.

h. Irrigation

Per-acre irrigation costs were taken from a weighted cost analysis of each of the proposed irrigation projects, i.e., Yamethin, Mu, Loikaw and Kandaw. The costs include depreciation, interest, maintenance, and operation expenses. The total returns of irrigation are increased over those of present cultivation methods by approximately K46.57 per acre without the advantages of modern farming or double cropping.

i. Demonstration Farms

Demonstration farms combine all the advantages of double cropping and modern farming appearing in the table analysis. The costs of training excess personnel and of hiring initial foreign technicians are not calculated in the cost estimate as they are not a recurring part of the program proposed and make no direct or continuing contribution toward increased agricultural production. Of five demonstration farms suggested for establishment in Section D–3, the one requiring the most machinery, and therefore the most expensive, was selected to serve as the cost analysis example.

j. Research and Extension

The contributions of research and extension toward increasing agricultural output were considered too intangible to permit proper evaluation under a cost analysis. Their field of activity would be intimately associated with all of the practices analyzed and their cost should probably be prorated among all of the suggestions discussed. The value of research and extension, if actively pursued, would probably exceed costs of application by many times.

The practices analyzed are, for the most part, treated alone. Their values are individual and in combination are additive or slightly more than additive. If present cultivation methods are employed, a paddy yield will approximate 1,300 pounds per acre. If improved seed is used, the yield will increase to 1,430 pounds. If fertilizer is also used the yield will increase to 1,820–1,860 pounds, etc. It becomes apparent that a wide variety of combinations for increased production is possible both under present cultivation methods and under varying degrees of improvement.

E. AGRICULTURAL AIMS AND SUGGESTED GOALS

1. PRESENT IMPROVEMENT MEASURES

The costs of present agriculture are not generally realized. A careful analysis reveals that a consideration of depreciation, interest and maintenance factors in calculating farm costs results in a per-acre cost to cultivate of approximately K42·7. This does not include the labor supplied by the farmer and his family amounting to an additional K25 per acre. If it is recognized that it presently costs the farmer K42·7 per acre in cash or in produce to cultivate his soil, the costs of improvements leading to much greater agricultural production and profit are better appreciated.

At present the improvement factors operating in Burma consist of providing improved paddy seed to farmers and the benefits of a thinly spread research and extension service. The costs of producing improved seed are entirely government borne and do not yield a very large per-acre return to Government. The effectiveness of present research and extension is not great.

2. A SUGGESTED PROGRAM

Budgeting requires careful consideration of how to obtain the greatest return for the least investment consistent with all the advantages and disadvantages that accompany any improvement method. With this in mind, a program has been prepared indicating the practices recommended and the acreage that would be devoted to each practice. Prewar production figures from the five-year average 1936–40 are used as a base for calculation purposes. Total acreage under cultivation at that time was 17,400,000. Improved seed was planted on 1,165,000 acres leaving the remaining 16,235,000 acres without improvements.

The suggestions for increasing agricultural production are based upon cost and general practicability. It is estimated that the use of improved seed could be extended to twice the present acreage by the target year 1960. The use of chemical fertilizer, being similar to improved seed in its quantity requirements, freight and distribution pattern, is estimated to be capable of extension to an acreage equal to that of improved seed before the war, or 1,164,000 acres. It is believed that partial mechanization and the proper use of manure could cover 10% of the acreage chemically fertilized, or 116,000 acres each. All of these practices are compatible with no irrigation, or stream diversion irrigation, and present cultivation methods.

Under reservoir irrigation, increased production would result from ample water supplied when needed any time of the year. The weighted average increase of all crops properly irrigated approximates 21%. This increase would also apply to the new acreage brought into cultivation by irrigation, land now fallowed, and land sown but annually abandoned due to drought. If irrigated, the fallowed, abandoned and new acreage would yield a normal crop which is equivalent, for calculation purposes, to an increase in cultivated acreage.

Modern farming, including demonstration farms with reservoir irrigation, seems to offer the best investment considering the expected returns. The hazards of improper establishment and poor management will be great with modern farming. The estimates however, both for cost and return, have assumed that farms would function near their optimum. A lowering of efficiency would have a depressing effect on expected returns. For those reasons the suggested acreage planned for modern farming is only 68,950 for the year 1960. Modern methods would produce two crops per year, and would enjoy all the advantages inherent in a mechanized operation.

Table VIII–20 (*see p.* 190) summarizes the benefits for the farmer and the Government under each of the suggested practices. Farm profits are calculated from a weighted nationwide average based on 1953 prices. Increased farm profits through the application of improved practices were calculated as the total value of the production increase less the farmer's cost of implementing the practice. The calculation of government profit used only the paddy portion of total production. It was assumed that all increases in paddy production would be exported. The export quantity was used to determine government profit with costs to Government first deducted.

The program suggested for 1960 would aim to improve, in varying degrees of intensity, approximately 1,165,000 acres. Most of the acreage improved would have two or more practices in effect. Thus about 7% of the cultivated land in Burma would be improved to some extent, principally in the use of improved seed and fertilizer. The 1960 goal is arbitrary, as are the methods selected and the degree of their individual application. The program would grow from its present status to that suggested for 1960 according to the funds invested in it and the practicability of establishing the various practices. Assuming the 1960 goal is justified on financial and practical grounds, the annual profit increment at the 1960 level of development would amount to over thirteen crores exclusive of cost. The annual cost to realize that increment would be about nine crores, or roughly a total return of 2½ crores per crore invested. The nine crore investment is, however, only the annual cost of improvements. The total investment necessary to realize the benefits of such improvement practices as irrigation would be much larger than the prorated annual costs shown in Table VIII–20. The suggested program would increase total profits by over 20% while improvements would extend to less than 7% of cultivated land.

F. CONCLUSIONS AND RECOMMENDATIONS

Burma is favored with large areas of flat land, a moderately fertile soil, ample water resources, and a suitable climate for agricultural production. Among Asian countries she is unique in having low population in relation to her potentially cultivable land. Burma has been a major exporter of rice for many years and is financially able to support improvement practices for increasing her agricultural output.

Roughly 16 million acres are presently under cultivation. This area lies in the Wet Zone, the Dry Zone and the hill country. It is estimated that approximately 1½ million acres are out of cultivation due to insurgency. Large tracts of land topographically suited for agriculture have never been cultivated. The principal crop, rice, occupies two thirds of all cultivated acreage with much lesser quantities of sesamum, maize, sugar cane, pulses, groundnuts, tobacco and cotton produced. Farming methods employ animals almost exclusively.

The problems of agriculture are essentially connected with low per-unit yields and are reflected in low national output. Associated problems are those of credit, taxation, research and extension, price control, and storage and marketing. The Land Nationalization Plan and the five-year Agricultural Development Plan should have far-reaching long-range effects on agriculture.

Increased agricultural production requires an intensification of present cultivated acreage, an extension of cultivation into areas not now cultivated or both. Intensification of present cultivation would be most effective in contributing to increased output. Under present farming methods, the program should be formulated on a practical basis consistent with the farmer's interest. It is believed that the use of chemical fertilizer and a service program of partial mechanization would be acceptable to the grower, would considerably increase the profits of farming, and would increase agricultural output. To a lesser degree improved storage and use of farmyard manure would do the same. With modern farming, all the advantages of scientific agriculture are possible and would result in very greatly increased production, reduced costs, and greater profits. Efforts should be concentrated on the production of agricultural commodities in short supply. The development of reservoir-irrigated programs, both under present and modern farming methods, would contribute significantly to increased agricultural production. The full benefits of irrigation are possible only under conditions of partial or complete mechanization of farming.

A research and extension program is discussed and specific emphasis is given to those phases of research that appear to be most urgent. The introduction of certain plant varieties and the improvement of others is of prime importance in the research field.

The various means of intensifying presently cultivated acreage were individually cost-analyzed to indicate both the investment required and the returns to be expected. The analyses were based upon the assumption that management and machinery would operate near the optimum levels of efficiency. These levels are obtainable if the program is undertaken modestly under competent management.

In accordance with the discussion of the various points of reference in this chapter, it is recommended:

(1) That action on National Agricultural Programs, including Land Nationalization, the Five-year Plan for Agricultural Self-sufficiency, financing the farmers, agricultural taxation, marketing of crops, the State Agricultural Marketing Board, and government organization for agriculture, be diligently pursued, with specific attention as follows:

a. The Land Nationalization Program

Every effort should be made to publicize and enforce the present laws thoroughly, the initial phase being limited to elimination of absentee ownership of tenant land and its distribution to present tenant cultivators; the purchase of owner-operated land in excess of 50 acres should be carried through, exceptions to the 50-acre limit being permitted where a cultivator has equipment necessary for mechanized farming and if there are surplus lands available; individual holders should be encouraged to farm their holdings jointly under a cooperative arrangement; periodic checks should be made to insure proper labor standards and production efficiency; changes in the management unit should be minimized and changes in land-holding right stressed; and the total program should be integrated with development of cooperatives, production methods, mechanization and the pursuit of other goals.

b. The Five-year Plan for Agricultural Self-sufficiency

The program selected by the Agricultural and Water Resources Development Corporation for immediate implementation should be diligently pursued with continued vigilance for additions and changes.

c. Financing the Farmers

To meet the problem of short-term credit, it will be necessary to carry out an intensive information program to educate the farmers in the proper use of credit, build up responsibility at the village level by insisting on adherence to certain minimum financial standards including contributions to share capital, continue the program to establish gradually district branches of the State Agricultural Banks in all districts, encourage repayment of loans in kind wherever possible, and establish procedures to enable the Agriculture Department to issue improved seed, fertilizers and implements on credit in conjunction with the system of state agricultural credit and the farm extension and demonstration services. Preparation should be made for the problem of long-term credit, even though it is not now a pressing one, so that future requirements for livestock purchase, land development, equipment purchase and other improvements may be accommodated.

d. Agricultural Taxation

Land revenues should not be increased until such time as persons in the income bracket of the cultivator are also subject to direct taxes. Since land records and crop statistics are basic data for determining land revenue, land records should be taken over by the agency managing state-owned lands under the land nationalization program, and collection of crop statistics should be separated from the tax collection function and established under an independent agency. Consideration should be given to making the land-revenue tax a source of local government revenue.

e. Marketing of Crops

Assistance should be given the farmers in getting better prices for their crops by formation of cooperatives, standardization of grades, adoption of uniform weights and measures, provisions for furnishing market information, price stabilization policies and inspection of weights and measures. The broad development, testing and regulation of standards should be legislatively assigned to a central scientific organization with enforcement vested in interested agencies. A market outlook service should be established to provide farmers with accurate information on current and expected prices and with timely forecasts of crop acreage and yield. Pricing programs should be set up on crops for which Government is prepared to enter the market and offer incentive prices for new crops such as jute and long stapled cotton. More cooperatives should be established through an expanded agricultural education and information program for acquainting the farmers

TABLE

A PROGRAM FOR INCREASING

(in

Practice	*1936–40*						
	Acres	*Tons Produced*	*Net Farm Profit*	*Net Government Profit*	*Total Return*	*Annual Cost to Implement*	*Total Profit*
			K	K	K	K	K
Improved Seed	1,165	67	9,860*d*	825*e*	20,010	9,325	—
Chemical Fertilizer	—	—	—	—	—	—	—
Partial Mechanization	—	—	—	—	—	—	—
Manure	—	—	—	—	—	—	—
Irrigation and Modernization	—	—	—	—	—	—	—
Irrigation and New Acreage	—	—	—	—	—	—	—
Irrigation of Fallow Acreage	—	—	—	—	—	—	—
Irrigation of Abandoned Acreage	—	—	—	—	—	—	—
Irrigation without Other Improvement	—	—	—	—	—	—	—
Total Profit by Improved Practices	—	—	9,860	825	—	—	10,685
Base Acreage Cultivated	17,400	8,060*a*	2,76,200*b*	3,36,000*c*	—	—	—
Acreage Increased by Irrigation	—	—	—	—	—	—	—
Total Profit by Unimproved Methods	—	—	2,76,200	3,36,000	—	—	6,12,200
Grand Total							6,22,885

a 0.464 ton per acre, the weighted nationwide average production of all crops.

b K15·9 per acre, the weighted nationwide average per-acre profit for all crops.

c Acreage × 67% (paddy) × ⅓ (exportable) × ·58 ton/acre × K150/acre.

d At K146.00 per ton with no cost to Government.

e At K150.00 per ton minus cost of production; see Table VIII–4.

f At 30% increase.

g Paddy only.

h At K146.00 per ton minus 50% cost of fertilizer.

i At K150.00 per ton minus 50% cost of fertilizer.

j At K146.00 per ton minus K30.34 per acre for machinery.

k At K150.00 per ton.

l At K146.00 per ton minus K3.16 per acre.

VIII - 20

AGRICULTURAL PRODUCTION

thousands)

1960

Acres	*Tons Produced*	*Net Farm Profit*	*Net Government Profit*	*Total Return*	*Annual Cost to Implement*	*Total Profit*
		K	*K*	*K*	*K*	*K*
2,330	135·2	19,720*d*	1,650*e*	40,020	18,650*t*	—
1,165	203	10,050*h*	11,050*i*	59,800	38,700*u*	—
116	75·4	7,480*j*	11,300*k*	23,300	3,520*v*	—
116	3·8	188·5*l*	570*k*	1,125	366·5*v*	—
69	82·6	15,006*o*	8,458*n*	23,358	106*o*	—
206·5	20	3,610*p*	1,867*q*	5,477	—	—
248	24	4,330*p*	2,240*q*	6,570	—	—
82	8	1,443*p*	740*q*	2,183	—	—
773	76	13,710*p*	10,510*r*	39,310	15,090*v*	—
—	—	75,537·5	48,385	2,00,143	76,220·5	1,23,922·5
17,400	8,060	2,76,200*b*	3,36,000	—	—	—
536·5	248·5*a*	8,525*b*	12,840*s*	31,825	10,460	—
—	—	2,84,725	3,48,840	—	—	6,33,565
						7,57,487·5

m At K180·5/ton (all crops) plus benefit of cheaper farming operations.

n Acreage × 67% (paddy) × $\frac{1}{3}$ (exportable) × 2 (double cropping) × 0·804 ton/acre minus normal exportable surplus and K19.50/acre for irrigation.

o Benefit of cheaper farming operation @ K1.44/acre (double cropped).

p At K180·5/ton.

q Acreage × 50% (paddy) × 0·121 ton/acre × K150 per ton.

r Same as *q*, but minus K19.50/acre for irrigation.

s Acreage × 50% (paddy) × 0·58 ton/acre × K150 per ton minus K19.50/acre for irrigation.

t Cost borne by Government.

u Cost 50% Government and 50% farmer.

v Cost borne by farmer.

with the basis for collective credit, transportation, market data, storage, threshing and simple processing.

f. State Agricultural Marketing Board

Rice should be sold more expeditiously in order to maximize sales at current favorable prices and hold existing markets. Earlier shipments should be made to relieve the rice storage problem. Storage facilities secure against insects, rodents and other spoilage should be provided. Bulk handling facilities should be constructed so that the Government will be able to store sufficient rice to spread its shipment over a larger period and take advantage of short-term fluctuations. The possibility of arranging trade agreements for sale of rice should be explored. An effort should be made to improve the quality of rice, encourage the use of improved seed and establish uniform standards of grading.

g. Government Organization for Agriculture

The principal agricultural functions should be brought together under one ministry. The staff of the secretariat of the ministry should be greatly strengthened to provide a small group of experienced agriculturists of administrative caliber to plan and expedite an integrated program. An agricultural information service should be established to prepare general and technical bulletins, publish popular periodicals and a farm magazine, and prepare special exhibits and equipment. It should use audio-visual programs. A central ministerial library with a qualified librarian should be set up. There should be a separate Department for Land Nationalization with a post of deputy secretary, and all agencies under the present ministry should be transferred to the new department with the exception of the crop reporting functions of the Commissioner of Settlement and Land Records which should be under the proposed Statistics Department. In addition the new Department for Land Nationalization should take over enforcement of rent controls and tenancy disposal. The Agriculture Department should be greatly expanded. The engineering functions of the Irrigation Department should be transferred to a Ministry of Engineering Services, and the Irrigation Department of the Ministry of Agriculture should retain only responsibility for operation and maintenance of irrigation works, supervision of application of water to the land, and relations with water users. A Cooperative Societies Department should be established in the Ministry of Agriculture to take over the program now planned by the Ministry of Land Nationalization as well as the agricultural cooperative program of the present Cooperative Department. The State Agricultural Credit Department, the Veterinary Department, the Fisheries Department, and the Forests Department should continue in their present functions with work of inspection and certification of livestock products added to the Veterinary Department. The planning staff proposed for the new ministry should take over all the planning of the Agricultural and Water Resources Development Corporation, and the corporation should be made responsible for funds only. The corporation should also be placed directly under a joint secretary for planning who would also be head of the planning staff. The SAMB should be an independent board directly under the President, and the composition of the board should be altered to provide adequate representation of all agencies concerned. The field staffs for all departments should be consolidated into one office to economize and standardize services and facilities such as transportation, housing and administration. The post of Financial Commissioner should be abolished.

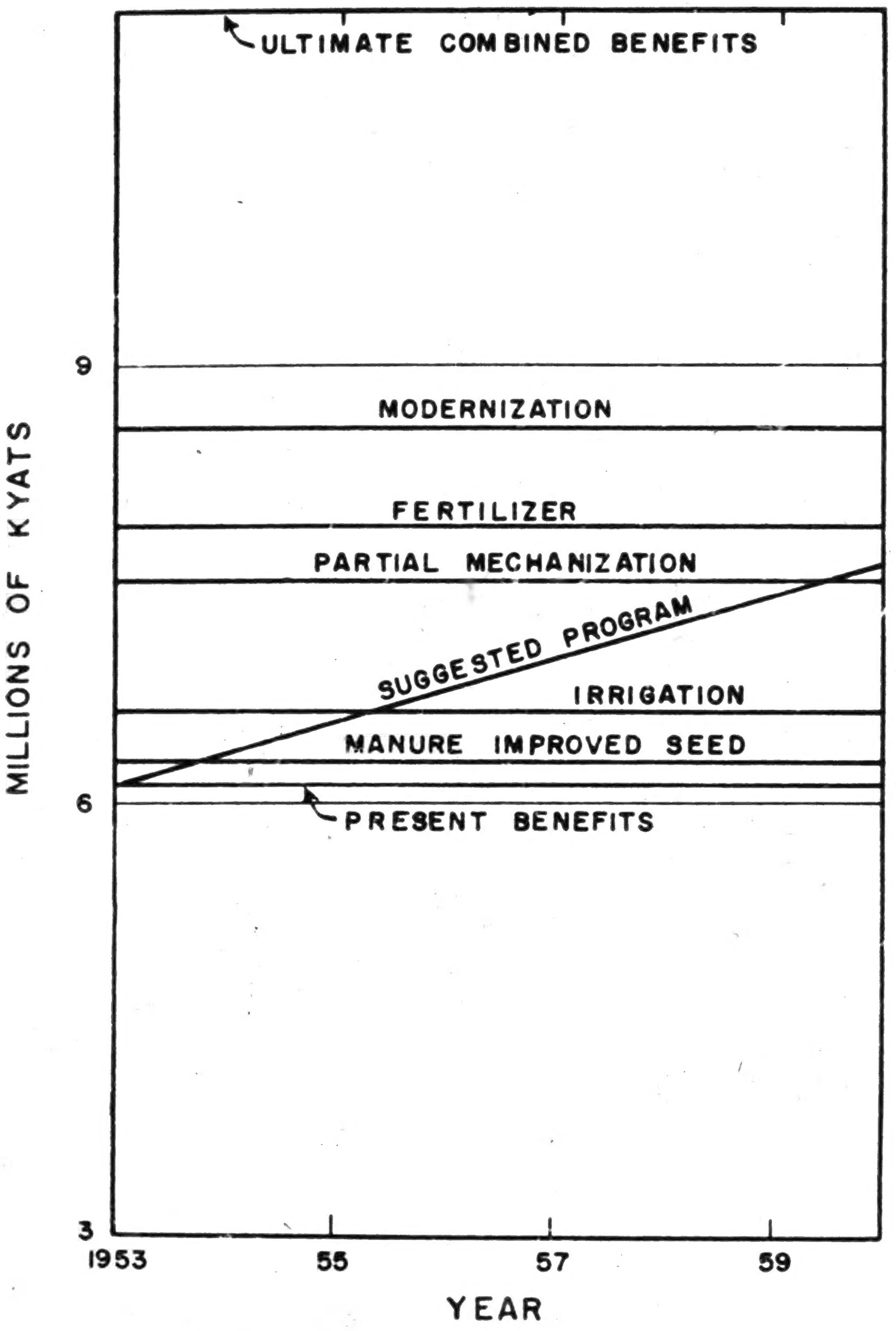
(2) That advanced agricultural practices including new irrigation projects for increase of agricultural production be introduced in accordance with a systematic program phased approximately as shown in Table VIII-20 and Plate 14.

(3) That five demonstration farms be established at the locations suggested on Plate 9.

(4) That research and extension be expanded in accordance with the organization shown on Plate 12. Immediate steps should be taken to implement the plan, with specific attention as follows:

a. Extension

Training in extension methods should be instituted immediately with courses at Mandalay College, the Agricultural Training Institute, and Central Farm Schools. A manual of extension methods should be prepared for use as a practical guide for workers. Fields of coverage should include basic information on soils, crops and farming methods, and the dissemination of information on the care and management of livestock. A program of establishing youth training groups should be started with each group selecting farm projects which will be planned by them with competent help and executed by them. Various means of implementing the research and extension programs should be adopted; for example, arranging for small-scale demonstrations in the villages on a variety of subjects as listed in the discussion, demonstrating desirable practices by means of sound and color films, distributing simple pamphlets and bimonthly or quarterly agricultural publications, and demonstrating agricultural methods by the efficient operation of a demonstration farm.



IT IS CONSIDERED THAT THE APPLICATION OF RECOMMENDED PRACTICES WOULD NOT EXCEED THE FOLLOWING PERCENTAGES OF PRESENT CULTIVATED ACREAGE:

IMPROVED SEED ········· 50% MANURE ·············· 30%
PARTIAL MECHANIZATION ·· 30% MODERNIZATION ·········· 20%
FERTILIZATION ··········· 50% IRRIGATION ·············· 7%

MINISTRY OF NATIONAL PLANNING

POTENTIAL BENEFITS OF IMPROVED PRACTICES

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON
DR.BY. E J P DATE PLATE
CK.BY. H.N JULY-53 NO. 14

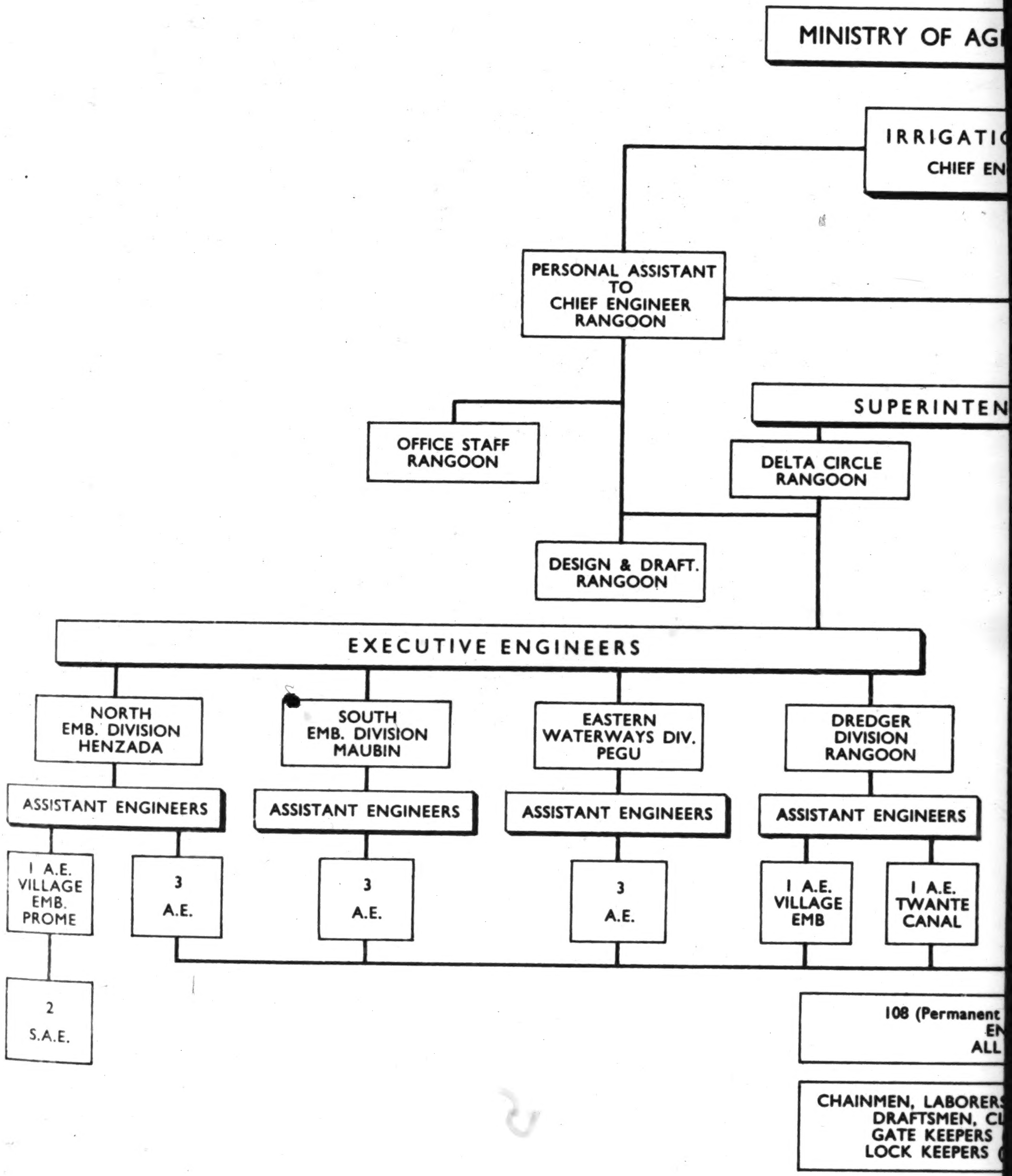
b. Research

Specific emphasis should be given to the introduction of new crops; improving seed other than paddy; classification of insects and establishing of control methods and costs; survey of indigenous diseases; and an investigation of trace element deficiencies in the soils and the establishment of the necessary library and laboratory facilities. Investigations should start with a survey and classification of the natural resources that would support a livestock industry, the areas best suited to livestock production, forage plant populations, supplies of supplementary feed, survey of livestock pests and diseases, livestock breeds best suited to the country, and possibilities for the processing of the various animal products. An agricultural engineering staff should be organized to develop methods of farming, for both mechanized equipment and improved implements. Aerial photo coverage of the whole of Burma should be undertaken, and should be used to its fullest in determining unknown land areas, boundaries, erosion conditions, drainage basins, possible communication routes, and administration of the land subsidy program. Within the framework of long-range agricultural research, land classification should be given immediate consideration with the objective of classifying land according to its basic resources and present condition.

c. Implementation

Effective research, if limited by insufficient funds, should be restricted in its coverage and complete in its intensity of application. The beginning extension program should be carried out to the tract level, and most support and emphasis should be given to local extension agents.

(5) That irrigation be developed in the areas of Yamethin, Loikaw, Mu River, and Kandaw Village in accordance with plans set forth in Chapter IX, including water services to the demonstration farms.


MINISTRY OF AG
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SUPERINTEN
OFFICE STAFF RANGOON
DELTA CIRCLE RANGOON
DESIGN & DRAFT. RANGOON
EXECUTIVE ENGINEERS
NORTH EMB. DIVISION HENZADA
SOUTH EMB. DIVISION MAUBIN
EASTERN WATERWAYS DIV. PEGU
DREDGER DIVISION RANGOON
ASSISTANT ENGINEERS
ASSISTANT ENGINEERS
ASSISTANT ENGINEERS
ASSISTANT ENGINEERS
1 A.E. VILLAGE EMB. PROME
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3 A.E.
3 A.E.
1 A.E. VILLAGE EMB
1 A.E. TWANTE CANAL
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IRRIGATION
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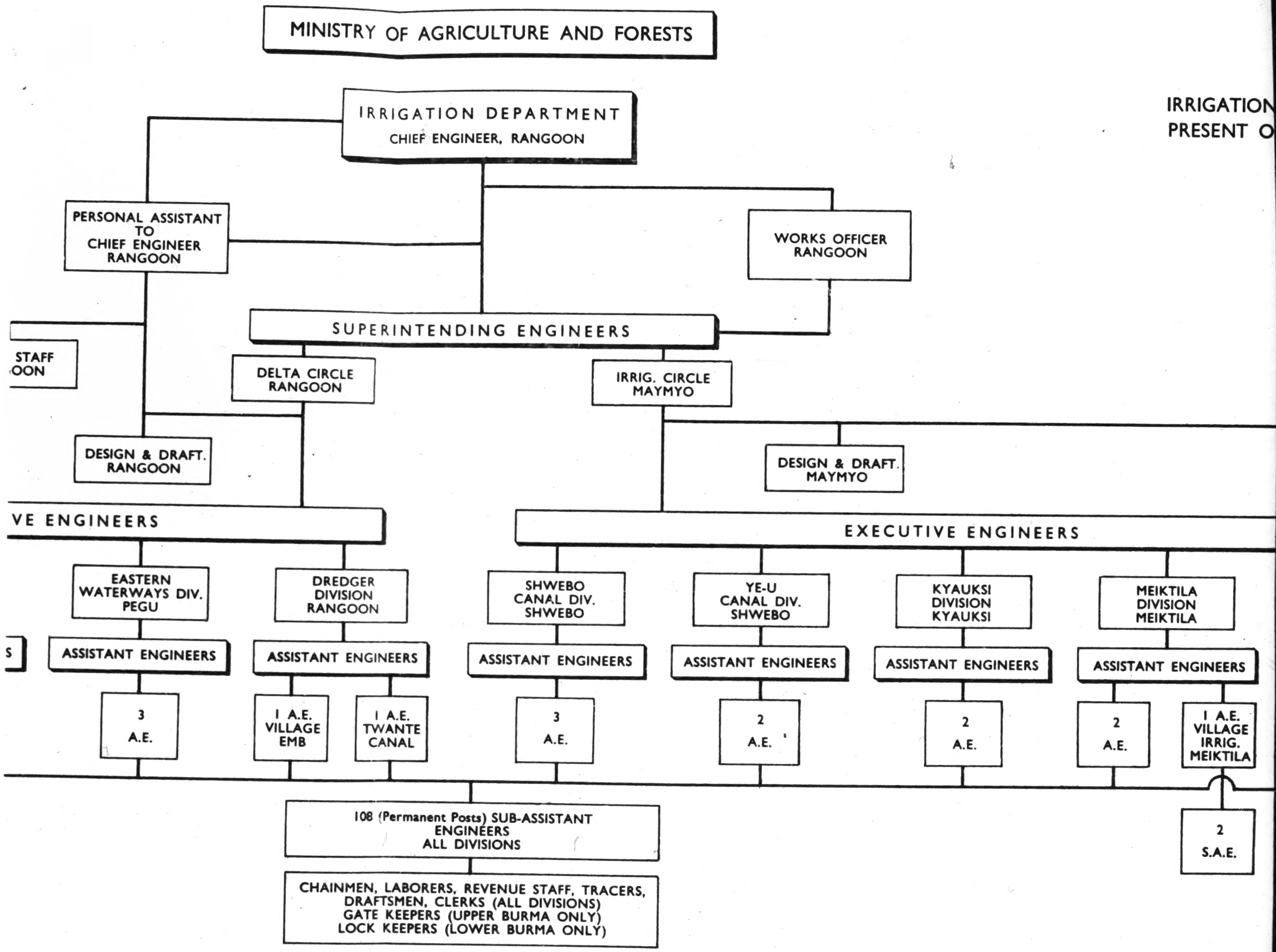
MINISTRY OF AGRICULTURE AND FORESTS
IRRIGATION DEPARTMENT
CHIEF ENGINEER, RANGOON
PERSONAL ASSISTANT TO CHIEF ENGINEER RANGOON
WORKS OFFICER RANGOON
SUPERINTENDING ENGINEERS
STAFF
OON
DELTA CIRCLE RANGOON
IRRIG. CIRCLE MAYMYO
DESIGN & DRAFT. RANGOON
DESIGN & DRAFT. MAYMYO
VE ENGINEERS
EXECUTIVE ENGINEERS
EASTERN WATERWAYS DIV. PEGU
DREDGER DIVISION RANGOON
SHWEBO CANAL DIV. SHWEBO
YE-U CANAL DIV. SHWEBO
KYAUKSI DIVISION KYAUKSI
MEIKTILA DIVISION MEIKTILA
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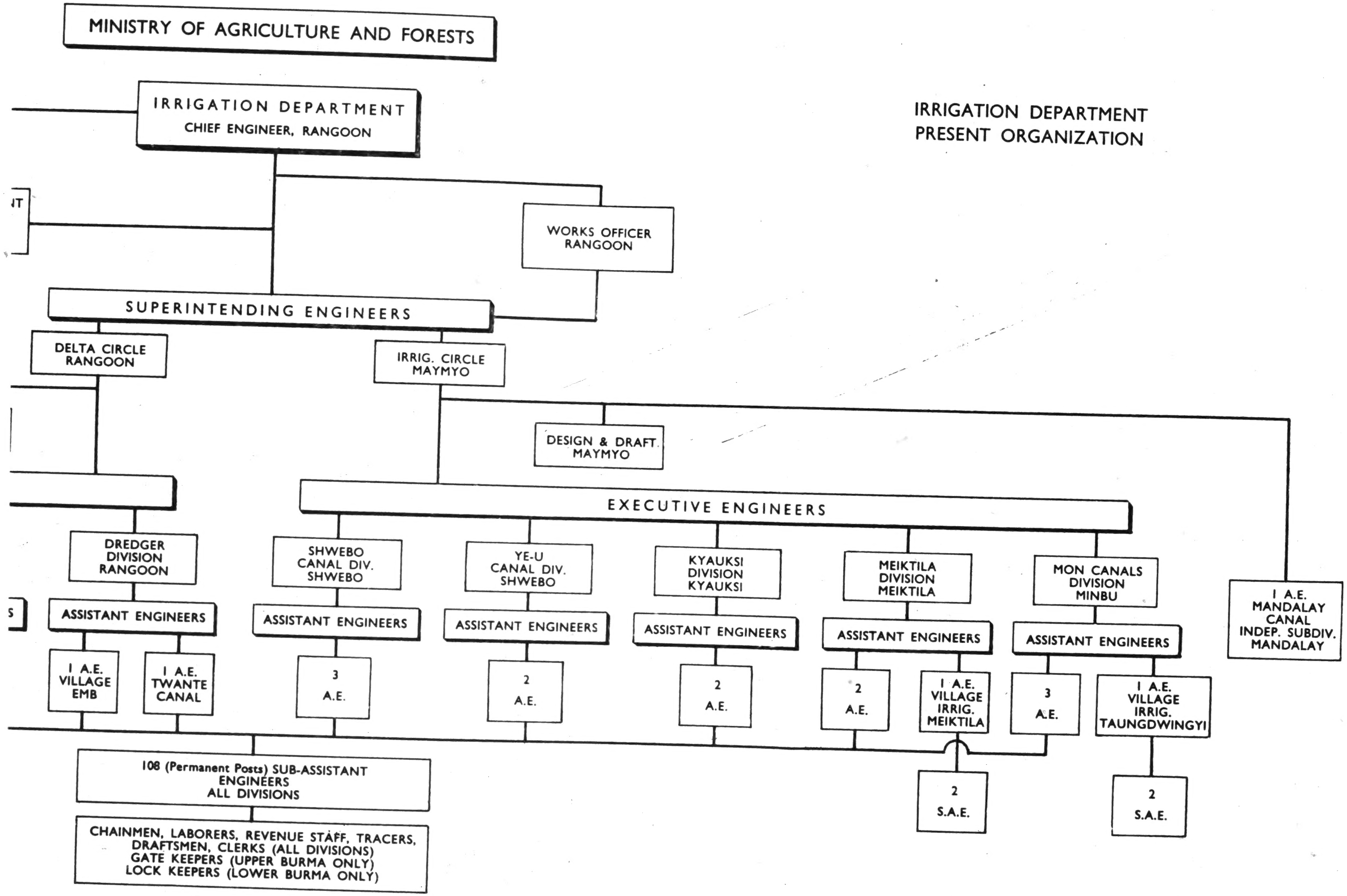
1 A.E. TWANTE CANAL
3 A.E.
2 A.E.
2 A.E.
2 A.E.
1 A.E. VILLAGE IRRIG. MEIKTILA
2 S.A.E.
108 (Permanent Posts) SUB-ASSISTANT ENGINEERS ALL DIVISIONS
CHAINMEN, LABORERS, REVENUE STAFF, TRACERS, DRAFTSMEN, CLERKS (ALL DIVISIONS) GATE KEEPERS (UPPER BURMA ONLY) LOCK KEEPERS (LOWER BURMA ONLY)

PLATE NO. I

IRRIGATION DEPARTMENT PRESENT ORGANIZATION



MINISTRY OF AGRICULTURE AND FORESTS
IRRIGATION DEPARTMENT
CHIEF ENGINEER, RANGOON
NT
WORKS OFFICER RANGOON
SUPERINTENDING ENGINEERS
DELTA CIRCLE RANGOON
IRRIG. CIRCLE MAYMYO
DESIGN & DRAFT. MAYMYO
EXECUTIVE ENGINEERS
DREDGER DIVISION RANGOON
SHWEBO CANAL DIV. SHWEBO
YE-U CANAL DIV. SHWEBO
KYAUKSI DIVISION KYAUKSI
MEIKTILA DIVISION MEIKTILA
MON CANALS DIVISION MINBU
I A.E. MANDALAY CANAL INDEP. SUBDIV. MANDALAY
S
ASSISTANT ENGINEERS
I A.E. VILLAGE EMB
I A.E. TWANTE CANAL
3 A.E.
2 A.E.
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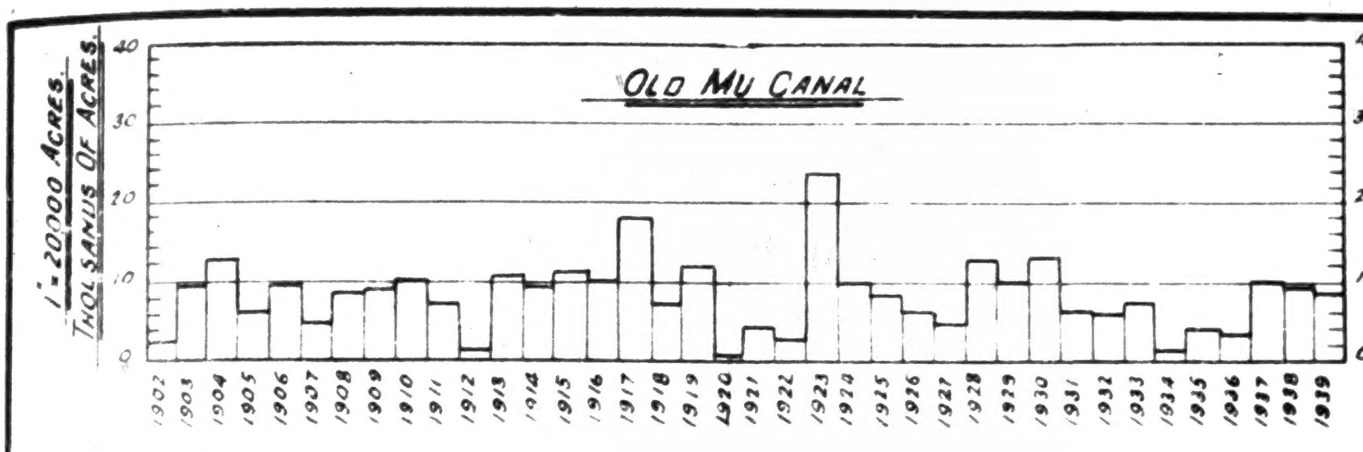
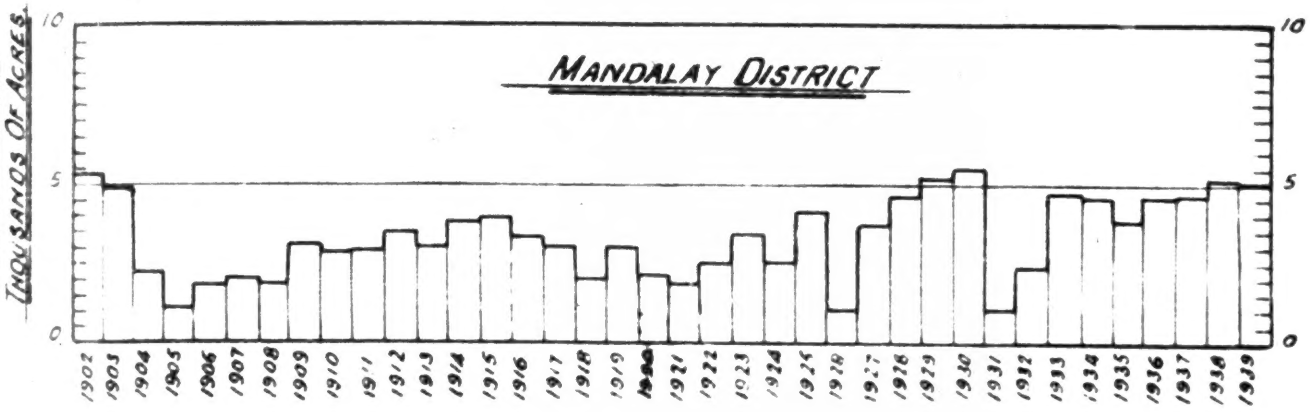
I A.E. VILLAGE IRRIG. MEIKTILA
3 A.E.
I A.E. VILLAGE IRRIG. TAUNGDWINGYI
2 S.A.E.
2 S.A.E.
108 (Permanent Posts) SUB-ASSISTANT ENGINEERS ALL DIVISIONS
CHAINMEN, LABORERS, REVENUE STAFF, TRACERS, DRAFTSMEN, CLERKS (ALL DIVISIONS) GATE KEEPERS (UPPER BURMA ONLY) LOCK KEEPERS (LOWER BURMA ONLY)


OLD MU CANAL
1" = 20,000 ACRES.
THOUSANDS OF ACRES.
0
10
20
30
40
1902
1939


MANDALAY DISTRICT
1" = 5000 ACRES.
THOUSANDS OF ACRES.
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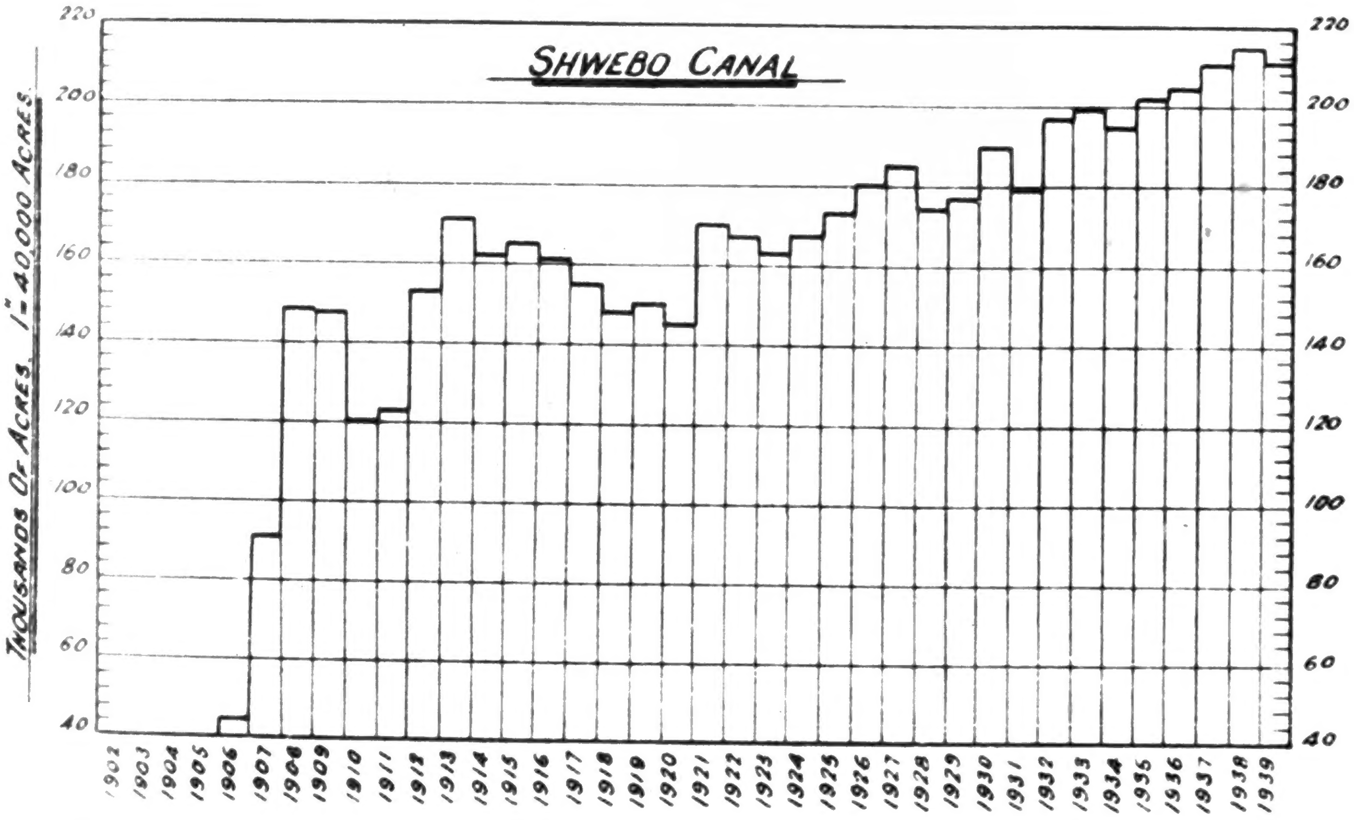
1902
1939


SHWEBO CANAL
THOUSANDS OF ACRES. 1" = 40,000 ACRES.
40
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80
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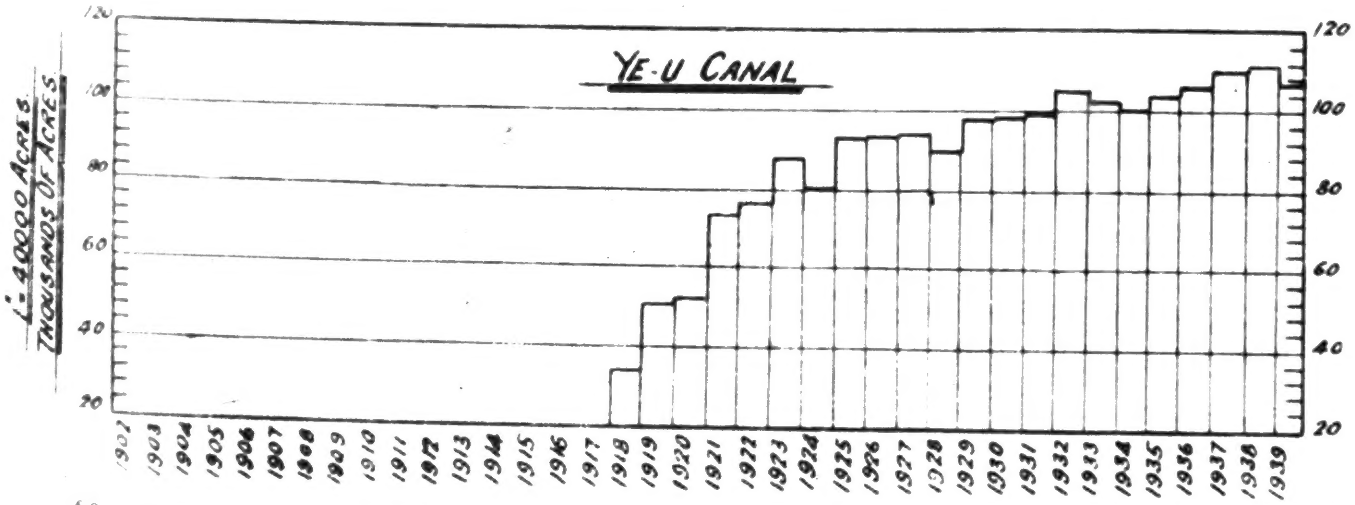
120
140
160
180
200
220
1902
1939


YE-U CANAL
1" = 40,000 ACRES.
THOUSANDS OF ACRES.
20
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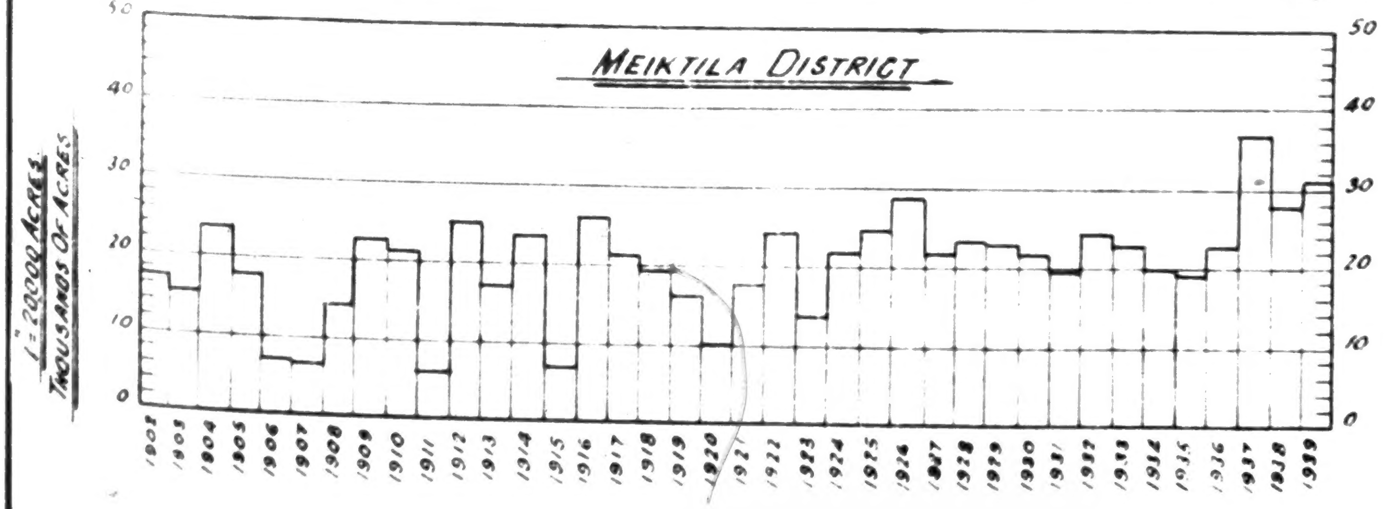
80
100
120
1902
1939


MEIKTILA DISTRICT
1" = 20,000 ACRES.
THOUSANDS OF ACRES.
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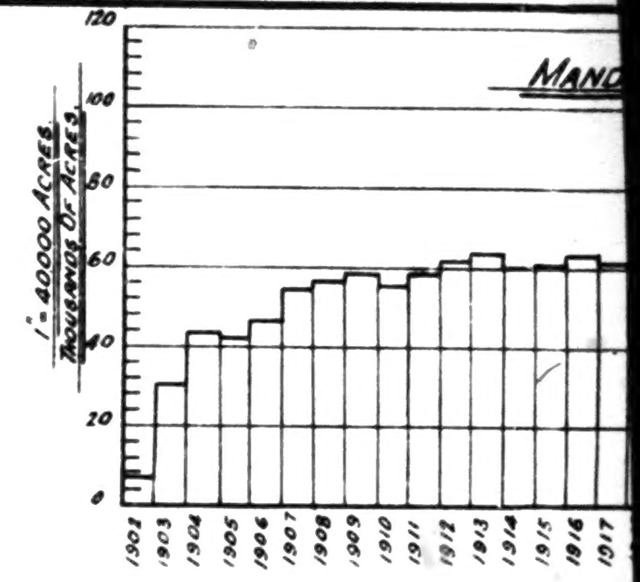
MAND
1" = 40,000 ACRES.
THOUSANDS OF ACRES.
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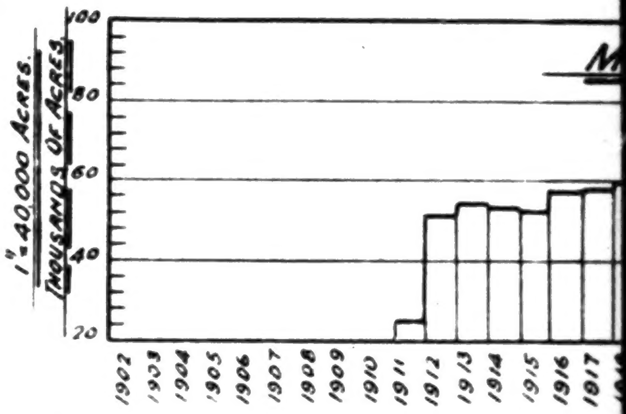
M
1" = 40,000 ACRES.
THOUSANDS OF ACRES.
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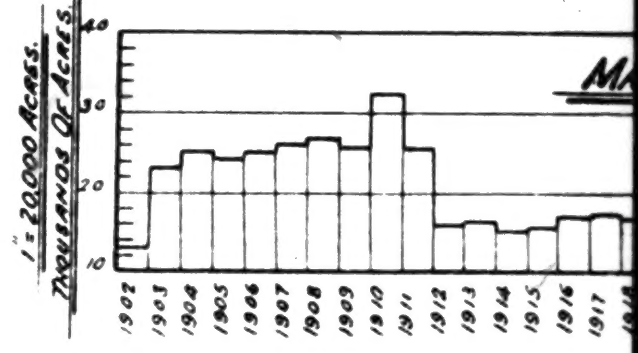
MA
1" = 20,000 ACRES.
THOUSANDS OF ACRES.
10
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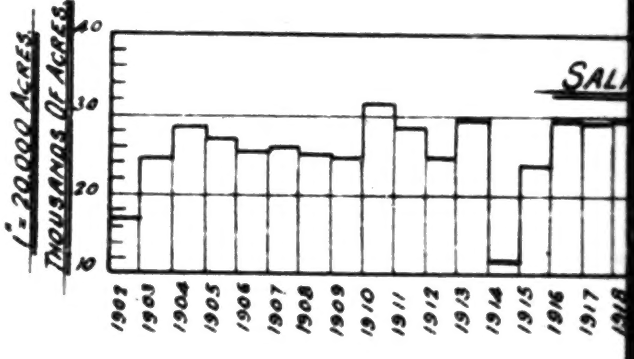
1902
1917


SAL
1" = 20,000 ACRES.
THOUSANDS OF ACRES.
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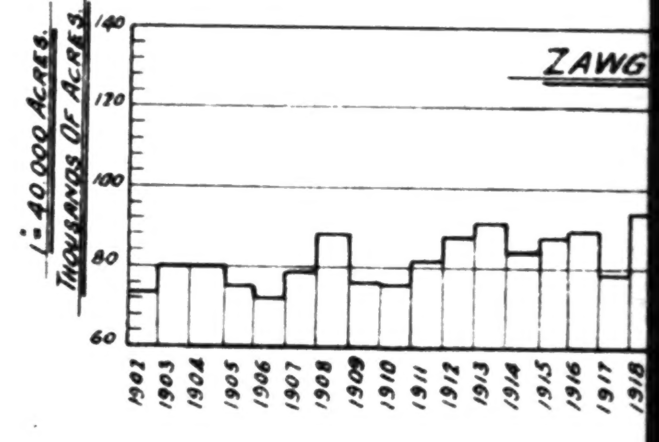
1902
1918


ZAWG
1" = 40,000 ACRES.
THOUSANDS OF ACRES.
60
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1902
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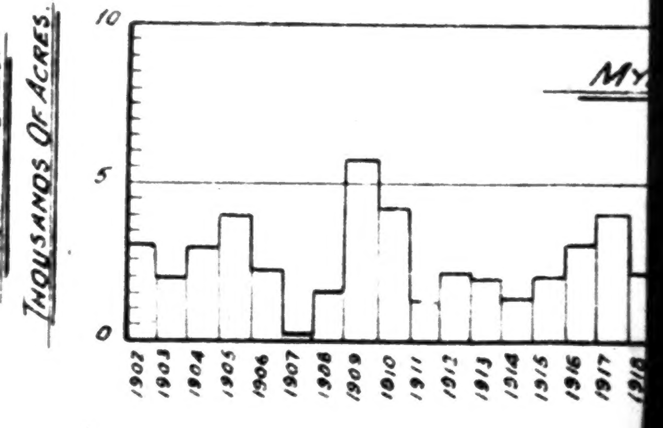
MY
1" = 5000 ACRES.
THOUSANDS OF ACRES.
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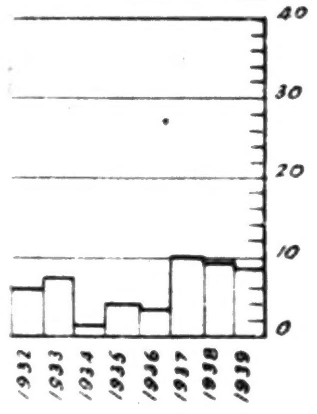
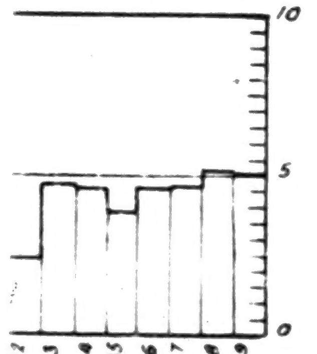
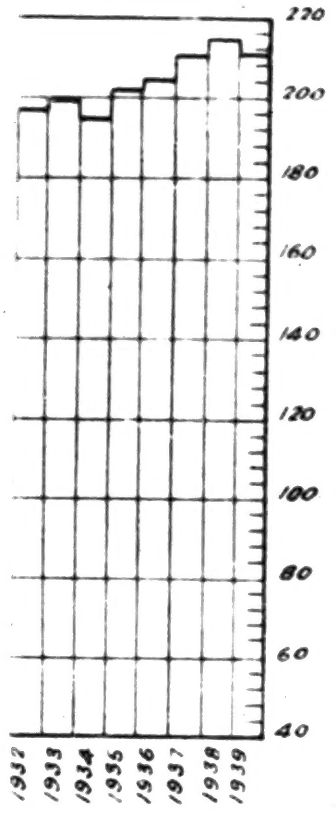
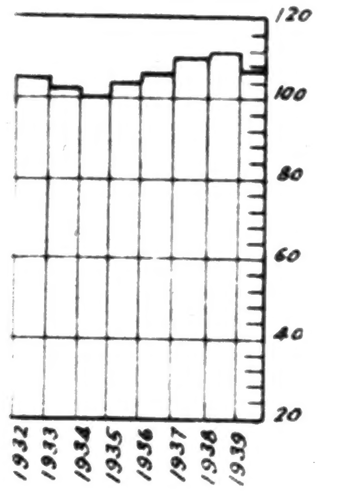
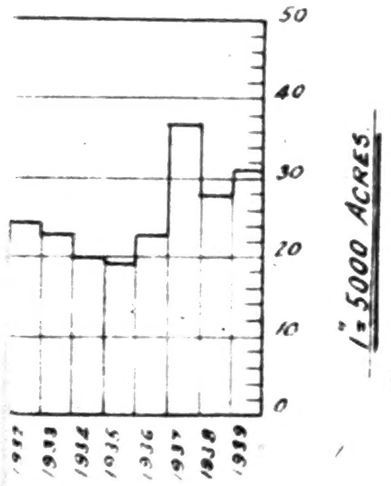
1918

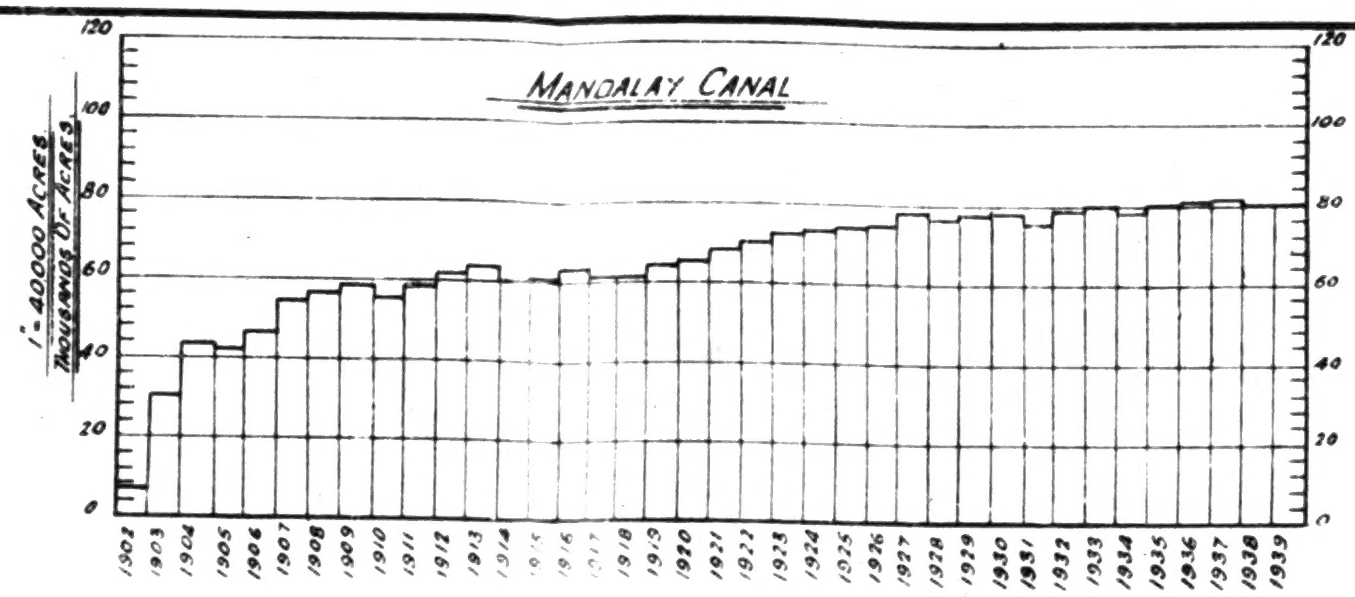


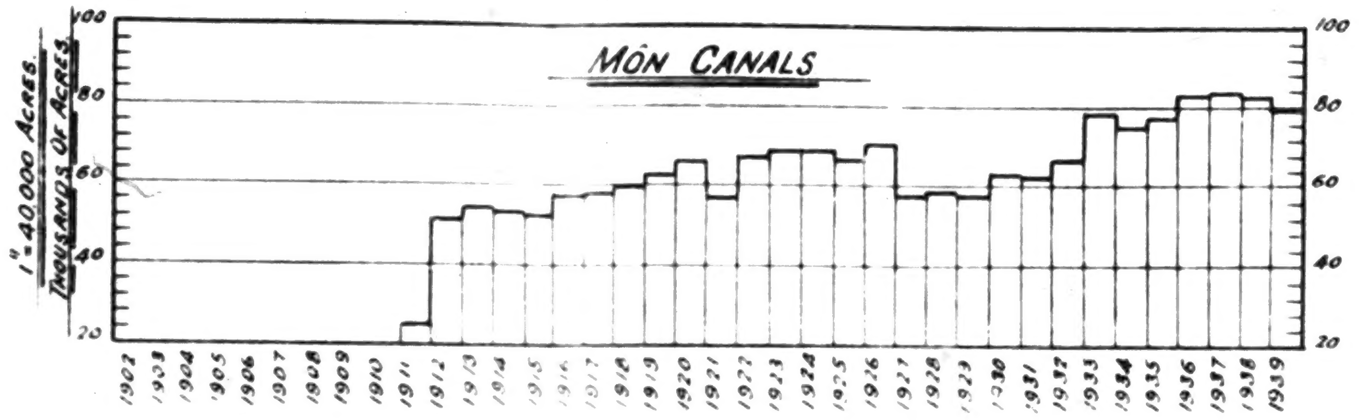


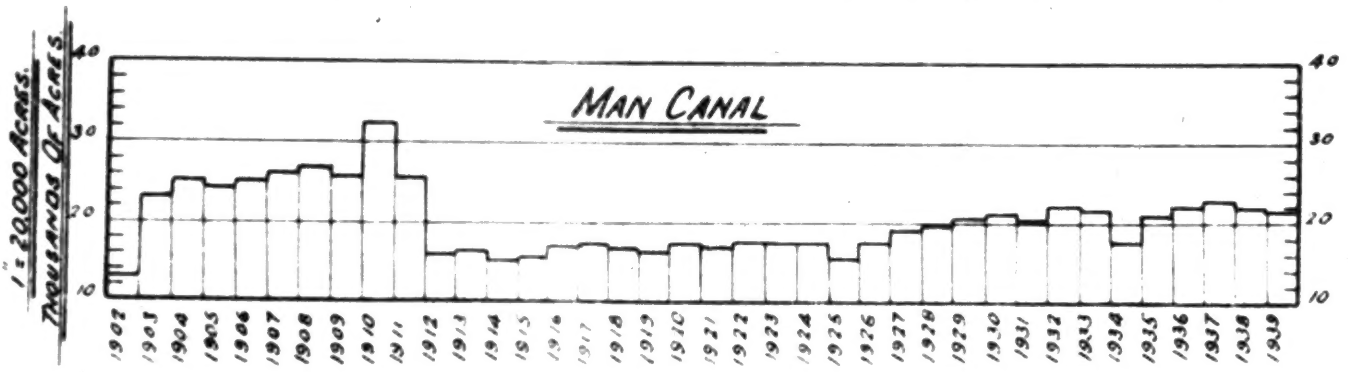


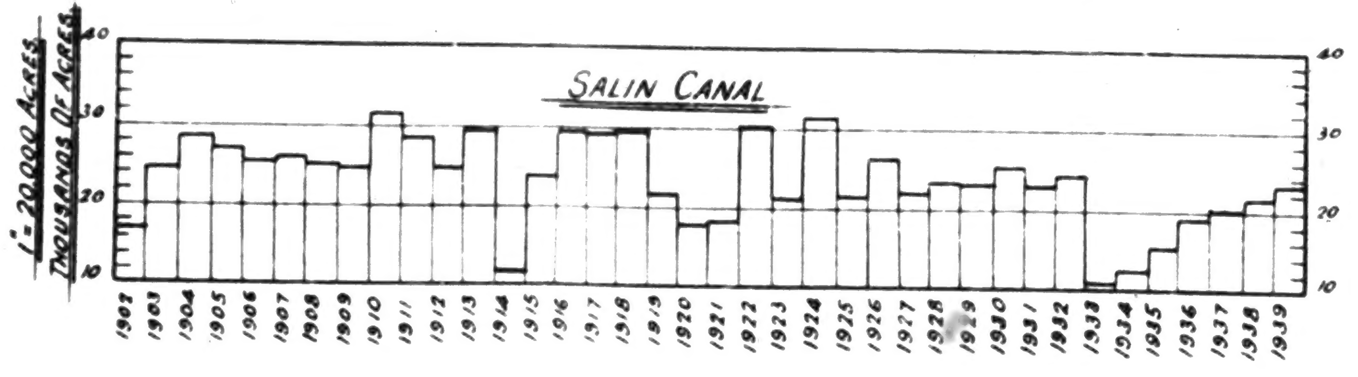


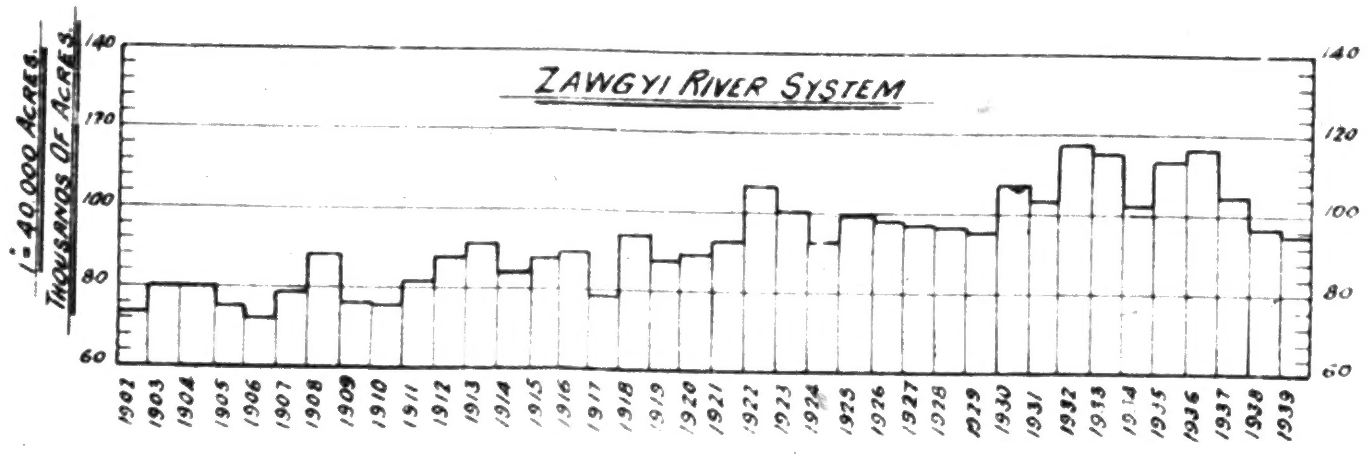


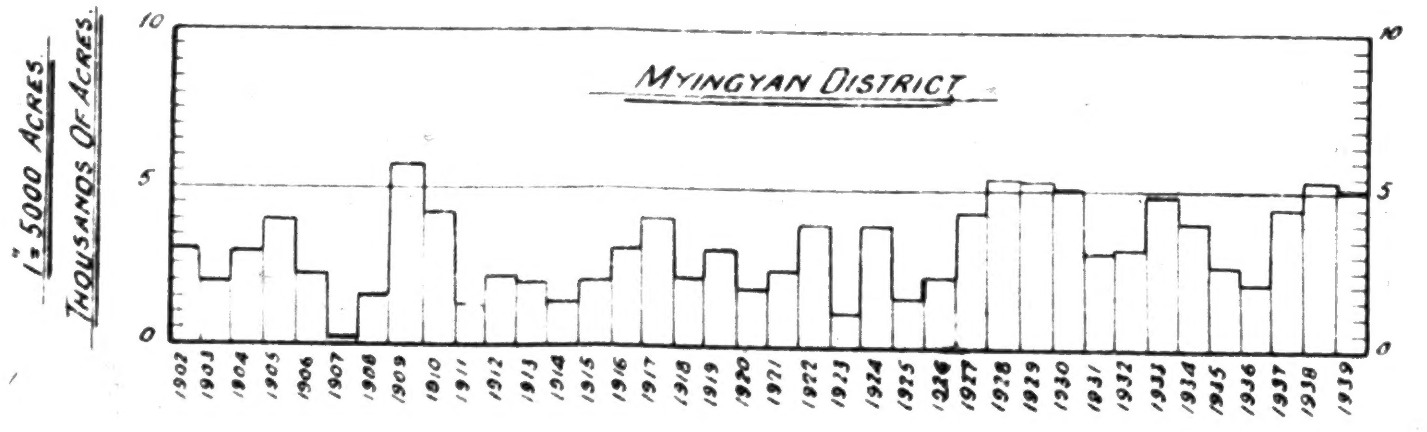


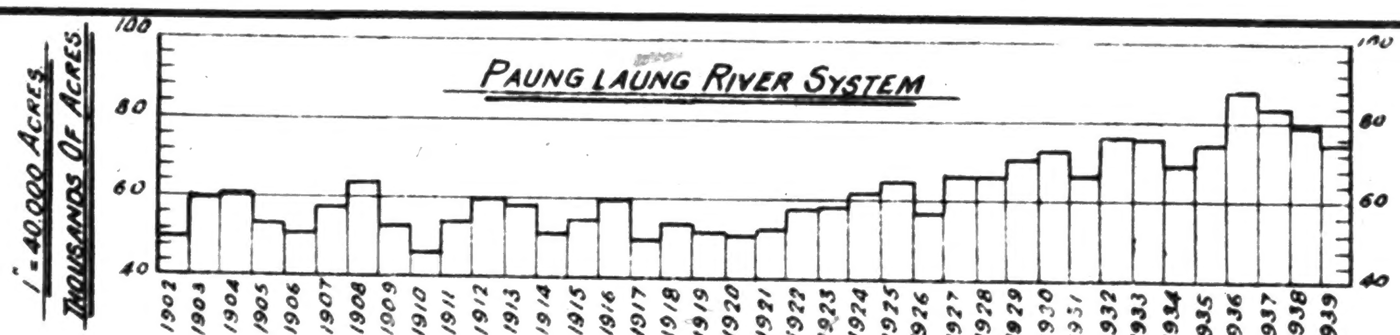


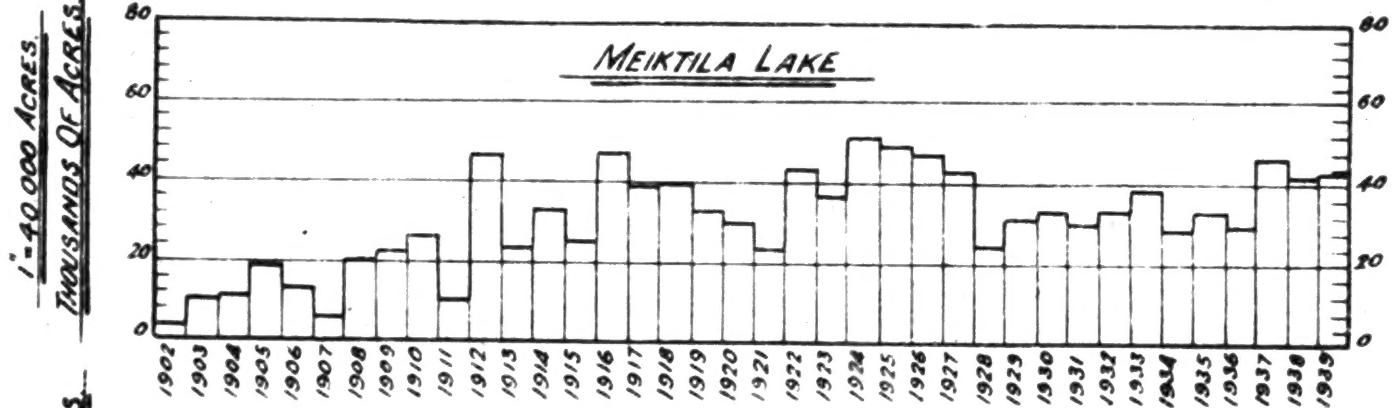


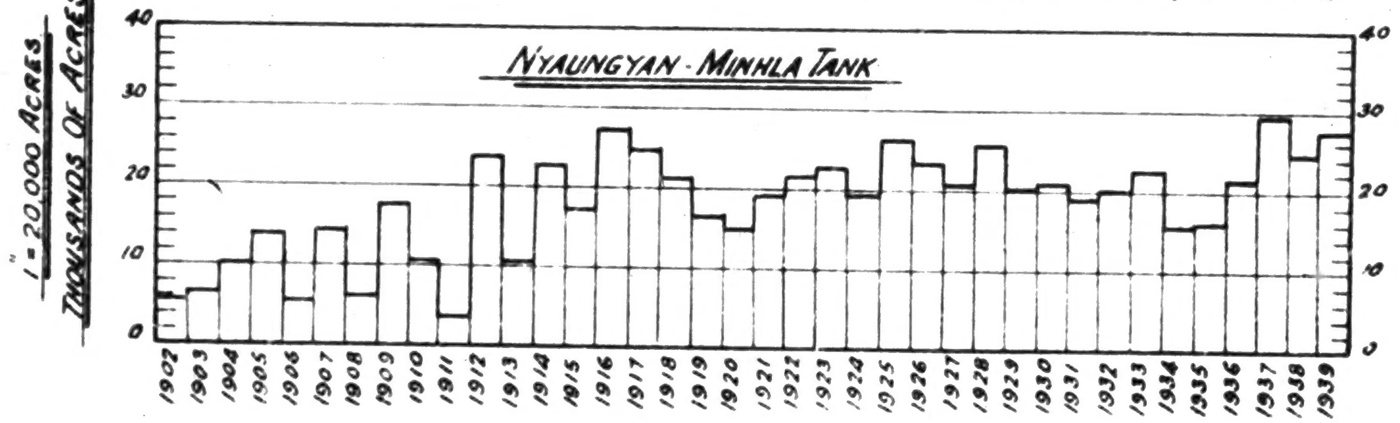


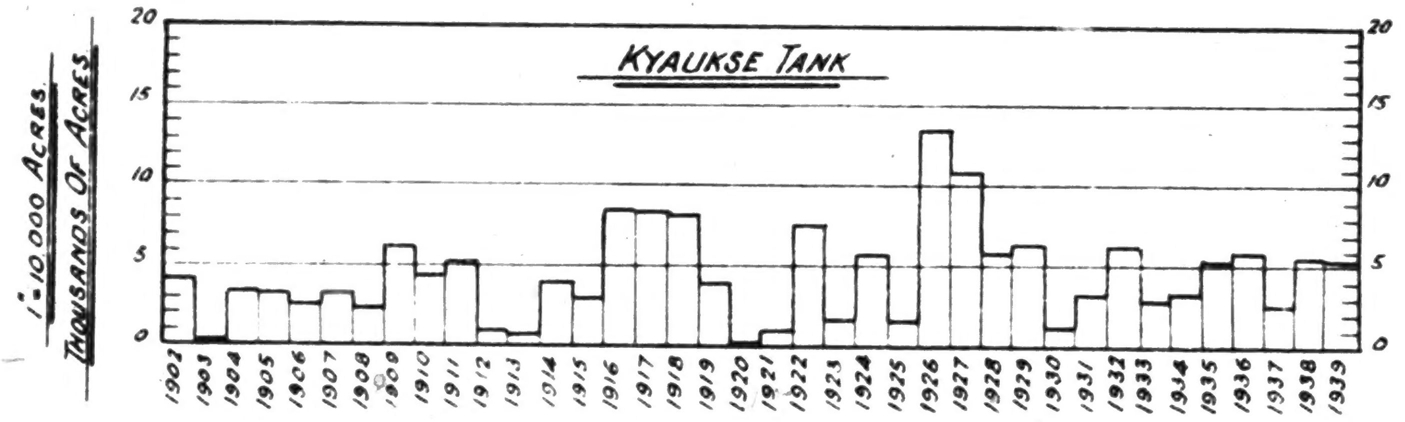


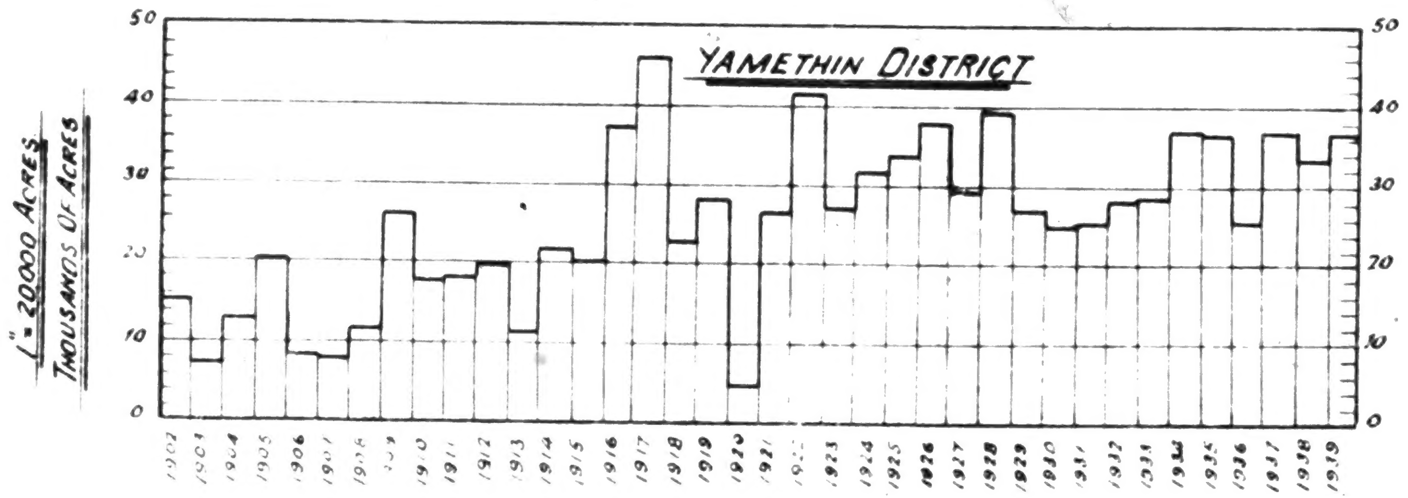










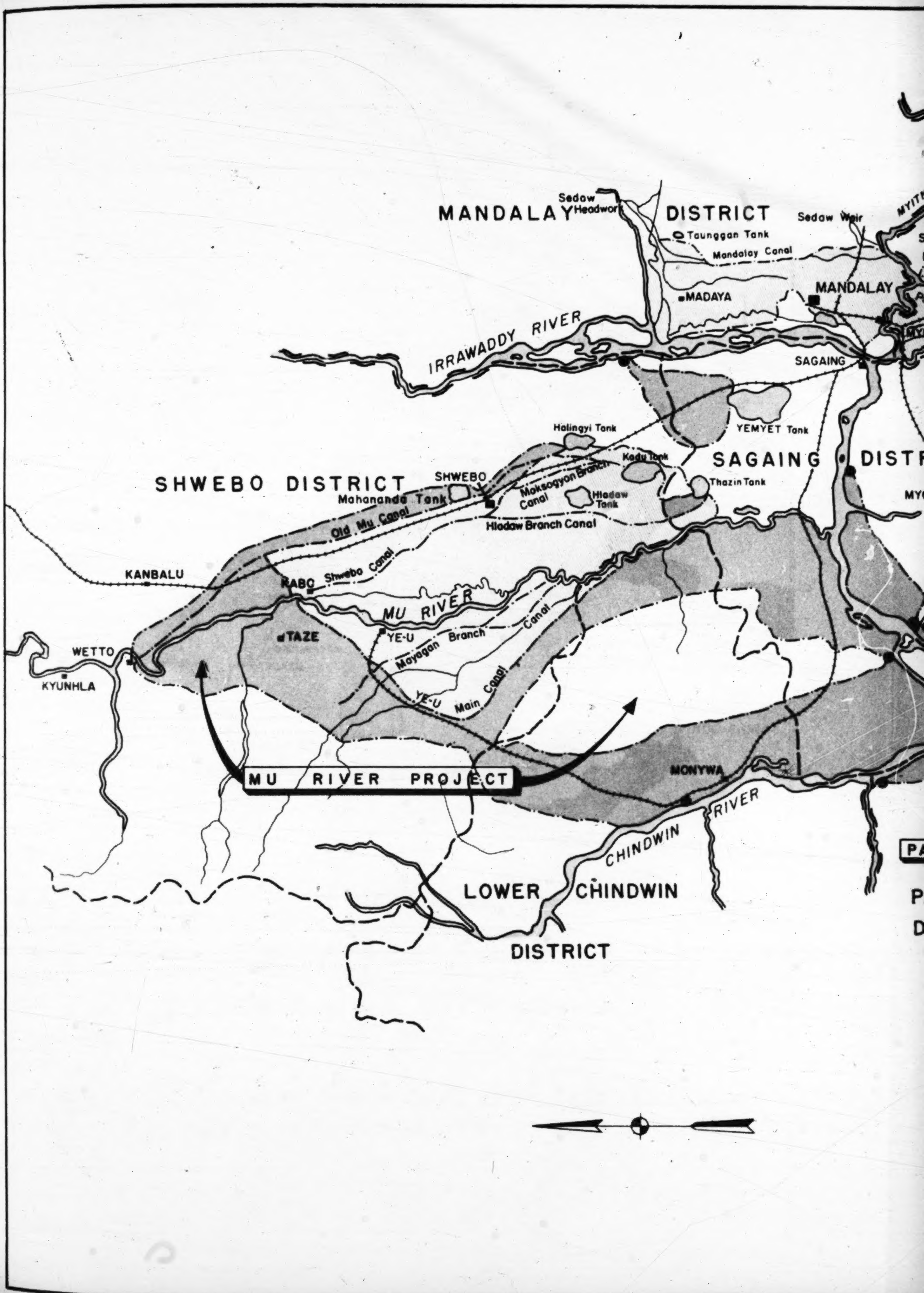


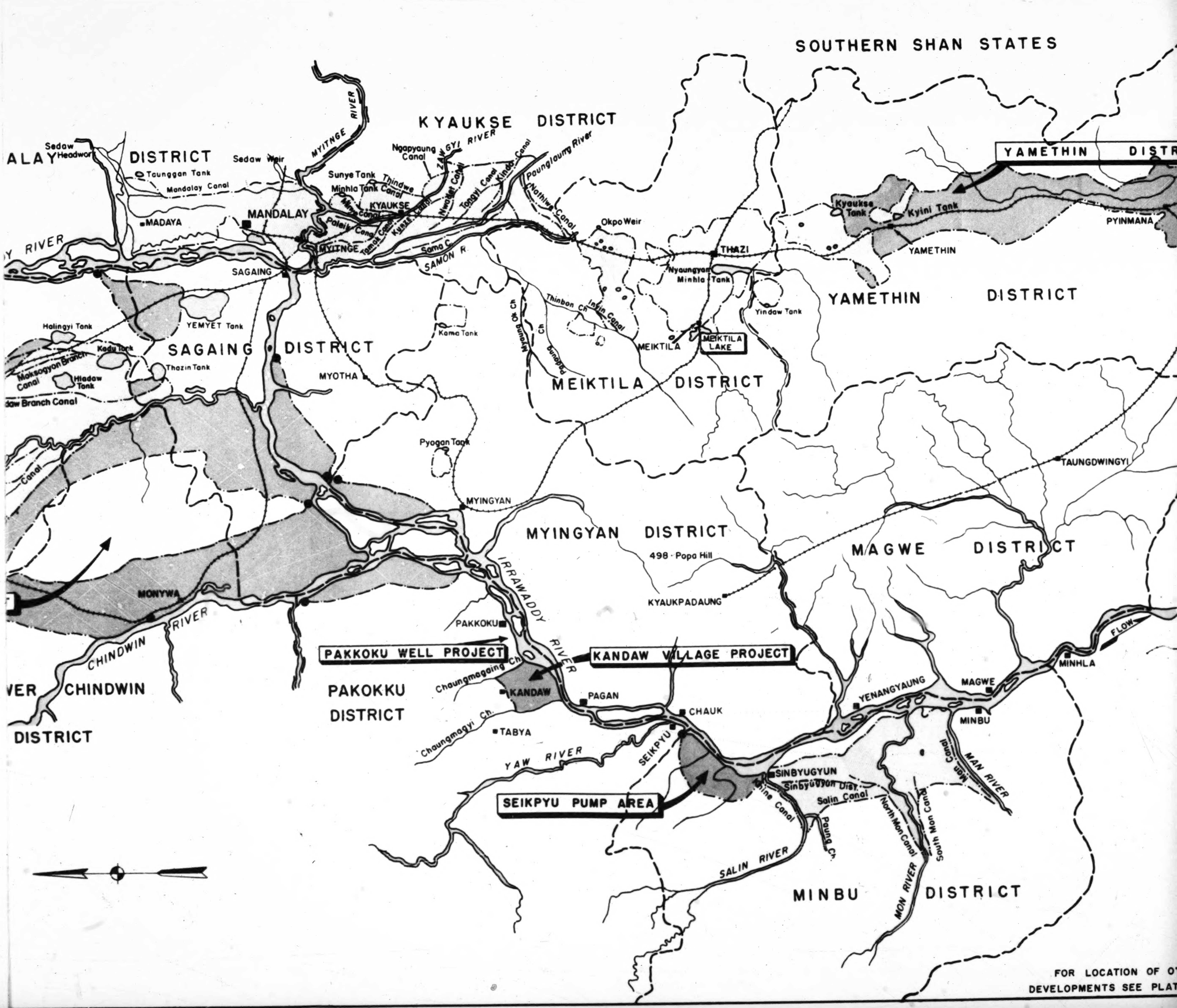
MINISTRY OF NATIONAL PLANNING.

PRESENT IRRIGATION SYSTEMS
AREAS IRRIGATED ANNUALLY.

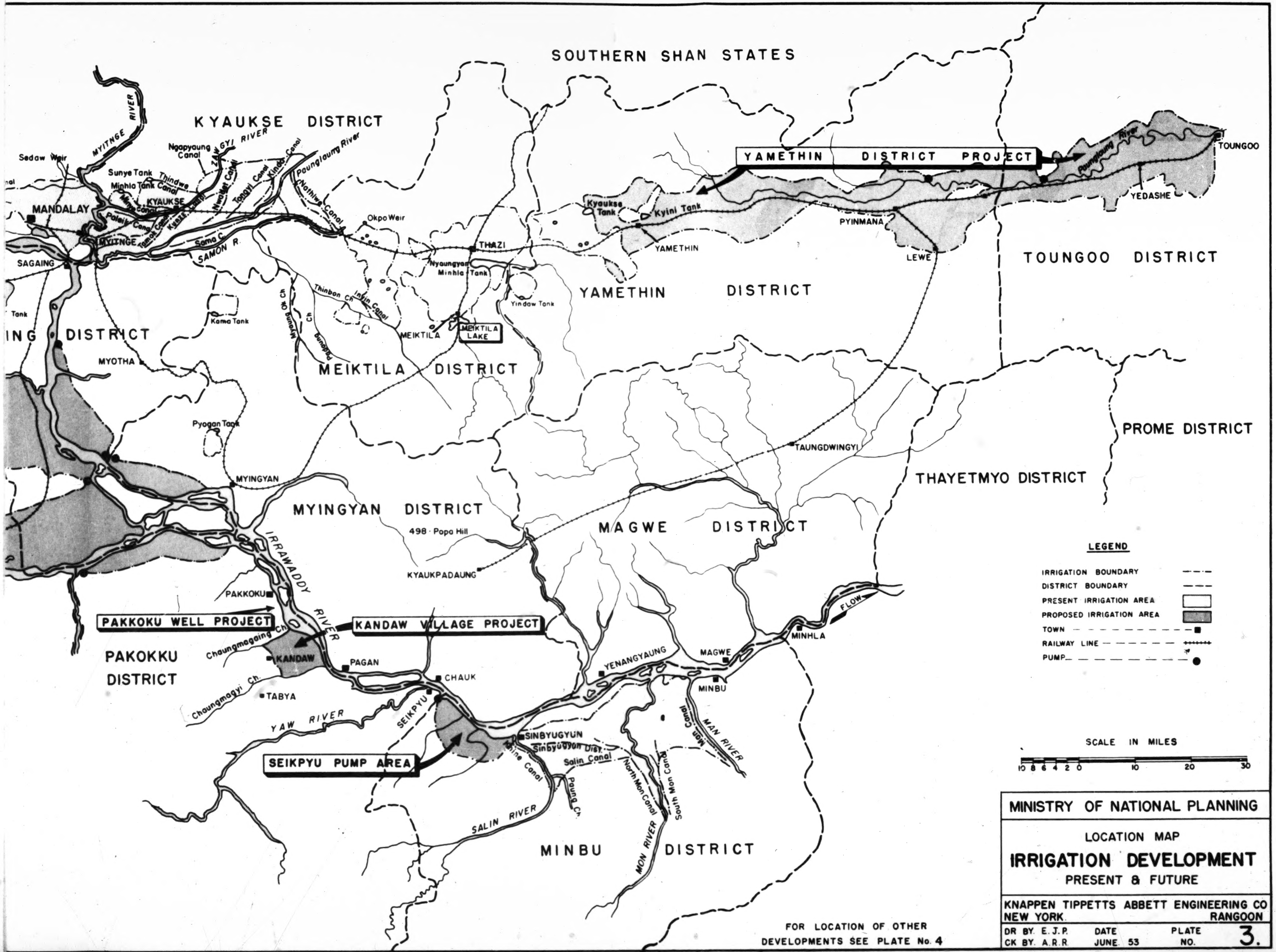
KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK. RANGOON.

DR. BY. E.J.P.	DATE	PLATE
CK. BY. A.R.R.	JUNE 53.	NO. 2


MANDALAY DISTRICT
Sedaw Headwor
Sedaw Weir
Taunggan Tank
Mandalay Canal
MADAYA
MANDALAY
IRRAWADDY RIVER
SAGAING
YEMYET Tank
Halingyi Tank
Kadu Tank
SAGAING DISTR
Thazin Tank
SHWEBO DISTRICT
SHWEBO
Mahananda Tank
Moksogyon Branch Canal
Hladaw Tank
Old Mu Canal
Hladaw Branch Canal
KANBALU
RABO
Shwebo Canal
MU RIVER
TAZE
YE-U
Mayagan Branch Canal
WETTO
KYUNHLA
YE-U Main Canal
MU RIVER PROJECT
MONYWA
CHINDWIN RIVER
LOWER CHINDWIN DISTRICT


SOUTHERN SHAN STATES
KYAUKSE DISTRICT
ALAY DISTRICT
Sedaw Headwor
Sedaw Weir
MYITNGE RIVER
ZAWGYI RIVER
Ngapyaung Canal
Sunye Tank
Thindwe Canal
Minhla Tank
Minye Canal
KYAUKSE
Kunze Canal
Nwadet Canal
Tongyi Canal
Kinda Canal
Paunglaung River
Nathlwe Canal
Okpo Weir
Taunggan Tank
Mandalay Canal
MADAYA
MANDALAY
Paleik Canal
Tamok Canal
MYITNGE
Sama C.
SAMON R.
Y RIVER
SAGAING
THAZI
Nyaungyan Minhla Tank
Yindaw Tank
YAMETHIN DISTR
Kyaukse Tank
Kyini Tank
PYINMANA
YAMETHIN
YAMETHIN DISTRICT
Halingyi Tank
YEMYET Tank
Kadu Tank
Moksogyon Branch Canal
Thazin Tank
Hladaw Tank
daw Branch Canal
SAGAING DISTRICT
MYOTHA
Kama Tank
Thinbon Ch.
Intin Canal
Ok Ch.
MEIKTILA
MEIKTILA LAKE
MEIKTILA DISTRICT
Pyogan Tank
Canal
MYINGYAN
TAUNGDWINGYI
MYINGYAN DISTRICT
498 · Popa Hill
MAGWE DISTRICT
KYAUKPADAUNG
MONYWA
CHINDWIN RIVER
IRRAWADDY RIVER
PAKKOKU
PAKKOKU WELL PROJECT
KANDAW VILLAGE PROJECT
Chaungmagaing Ch.
KANDAW
PAGAN
CHAUK
YENANGYAUNG
MAGWE
MINHLA
FLOW
MINBU
WER CHINDWIN DISTRICT
PAKOKKU DISTRICT
TABYA
Chaungmagyi Ch.
YAW RIVER
SEIKPYU
SINBYUGYUN
Sinbyugyun Dist.
Salin Canal
Shine Canal
SEIKPYU PUMP AREA
Paung Ch.
North Mon Canal
South Mon Canal
Man Canal
MAN RIVER
SALIN RIVER
MON RIVER
MINBU DISTRICT

FOR LOCATION OF OT
DEVELOPMENTS SEE PLAT


SOUTHERN SHAN STATES
KYAUKSE DISTRICT
MYITNGE RIVER
Sedaw Weir
Ngapyaung Canal
ZAWGYI RIVER
Sunye Tank
Thindwe Canal
Minhla Tank Canal
Minye Canal
KYAUKSE
Kunze Canal
Nwadet Canal
Tongyi Canal
Kinda Canal
Paunglaung River
Nathlwe Canal
nal
MANDALAY
Paleik Canal
Tamok Canal
MYITNGE
Sama C.
SAMON R.
SAGAING
Okpo Weir
THAZI
Nyaungyan Minhla Tank
Yindaw Tank
Tank
ING DISTRICT
Kama Tank
Thinbon Ch
Inyin Canal
Ch
Ok Ch
MEIKTILA
MEIKTILA LAKE
MYOTHA
MEIKTILA DISTRICT
Pyogan Tank
MYINGYAN
YAMETHIN DISTRICT PROJECT
Kyaukse Tank
Kyini Tank
YAMETHIN
PYINMANA
LEWE
Paunglaung River
TOUNGOO
YEDASHE
YAMETHIN DISTRICT
TOUNGOO DISTRICT
PROME DISTRICT
TAUNGDWINGYI
THAYETMYO DISTRICT
MYINGYAN DISTRICT
498 · Popa Hill
KYAUKPADAUNG
MAGWE DISTRICT
IRRAWADDY RIVER
PAKKOKU
PAKKOKU WELL PROJECT
KANDAW VILLAGE PROJECT
Chaungmagaing Ch
KANDAW
PAGAN
CHAUK
PAKOKKU DISTRICT
Chaungmagyi Ch.
TABYA
YAW RIVER
SEIKPYU
SEIKPYU PUMP AREA
YENANGYAUNG
MAGWE
MINBU
MINHLA
FLOW
SINBYUGYUN
Sinbyugyun Dist.
Salin Canal
Paung Ch.
North Mon Canal
South Mon Canal
Man Canal
MAN RIVER
MON RIVER
SALIN RIVER
MINBU DISTRICT
LEGEND
IRRIGATION BOUNDARY
DISTRICT BOUNDARY
PRESENT IRRIGATION AREA
PROPOSED IRRIGATION AREA
TOWN
RAILWAY LINE
PUMP
SCALE IN MILES
10 8 6 4 2 0
10
20
30

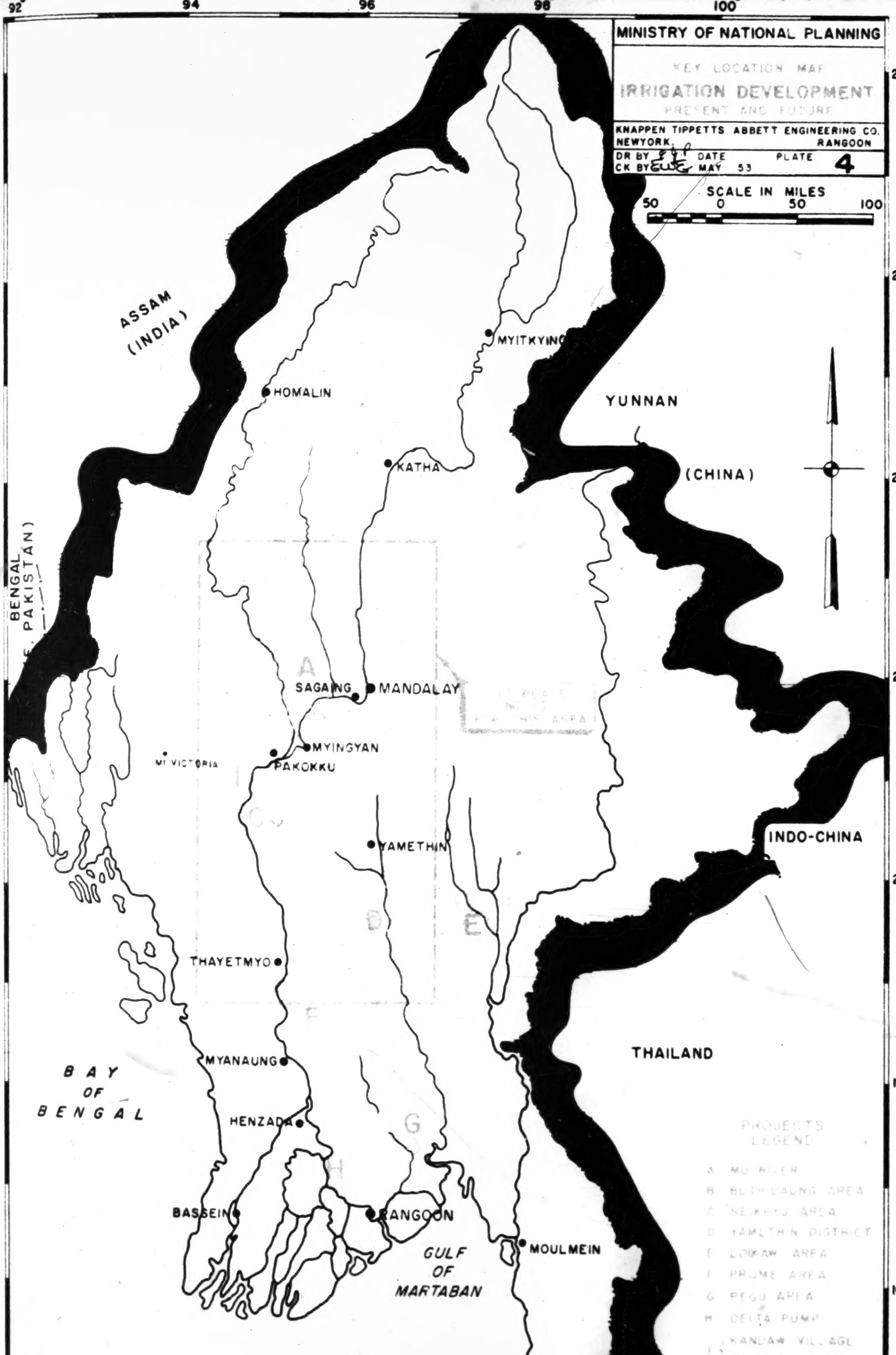
FOR LOCATION OF OTHER DEVELOPMENTS SEE PLATE No. 4

MINISTRY OF NATIONAL PLANNING

LOCATION MAP
IRRIGATION DEVELOPMENT
PRESENT & FUTURE

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON

DR BY. E. J. P.	DATE	PLATE
CK BY. A. R. R.	JUNE. 53	NO. 3.

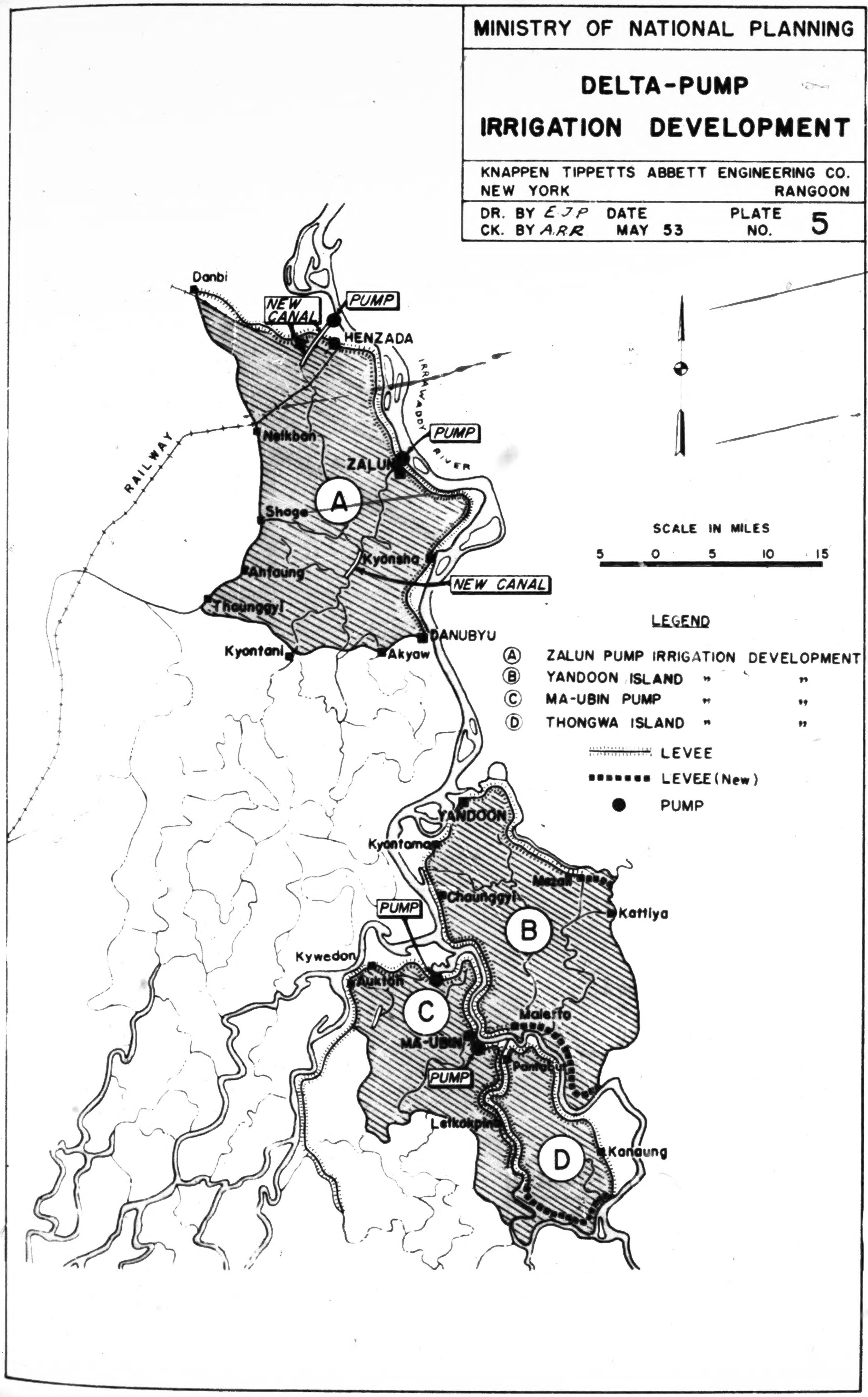

MINISTRY OF NATIONAL PLANNING
KEY LOCATION MAP
IRRIGATION DEVELOPMENT
PRESENT AND FUTURE
KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEWYORK. RANGOON
DR BY
CK BY
DATE
MAY 53
PLATE
4
SCALE IN MILES
50
0
50
100
92°
94°
96°
98°
100°
28°
26°
24°
22°
20°
18°
16°
ASSAM
(INDIA)
BENGAL
(E. PAKISTAN)
YUNNAN
(CHINA)
INDO-CHINA
THAILAND
BAY OF BENGAL
GULF OF MARTABAN
MYITKYINA
HOMALIN
KATHA
SAGAING
MANDALAY
MYINGYAN
PAKOKKU
MT VICTORIA
YAMETHIN
THAYETMYO
MYANAUNG
HENZADA
BASSEIN
RANGOON
MOULMEIN
A
C
D
E
F
G
H
[illegible] PLATE
NO.
FOR THIS AREA
PROJECTS
LEGEND
A MU RIVER
B BUTHIDAUNG AREA
C SEIKPYU AREA
D YAMETHIN DISTRICT
E LOIKAW AREA
F PROME AREA
G PEGU AREA
H DELTA PUMP
I KANDAW VILLAGE
PAKOKKU PUMP

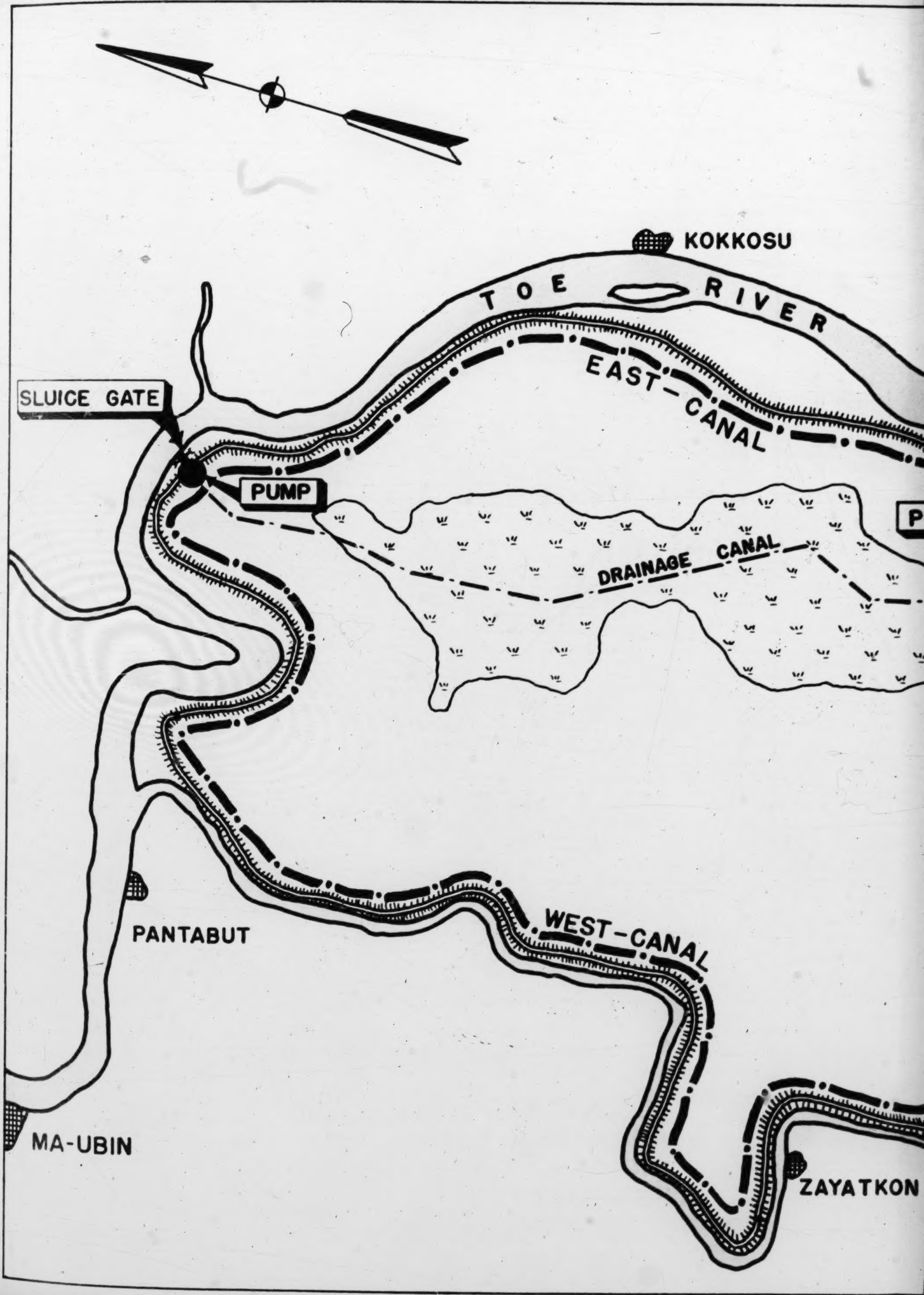
MINISTRY OF NATIONAL PLANNING

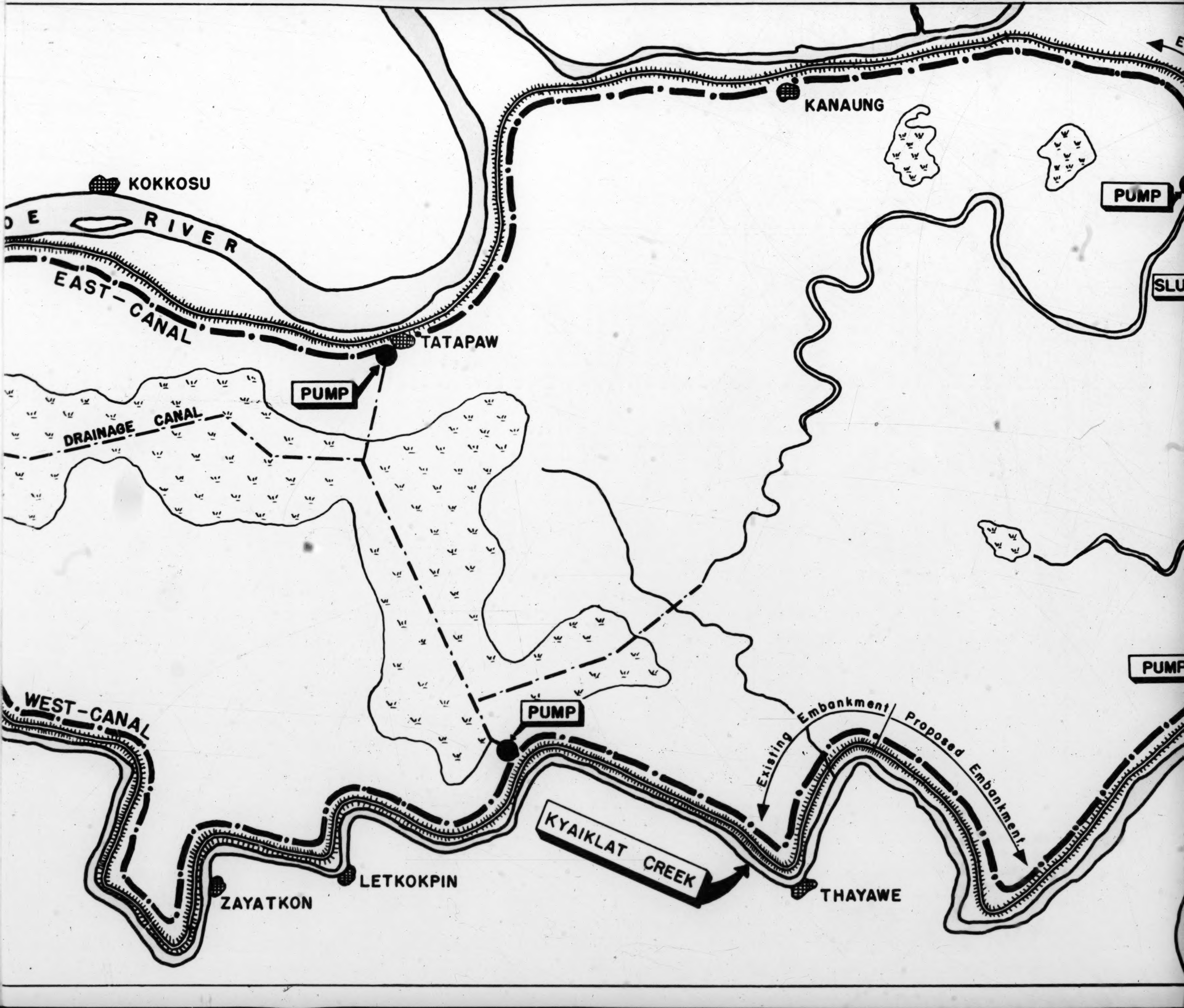
DELTA-PUMP IRRIGATION DEVELOPMENT

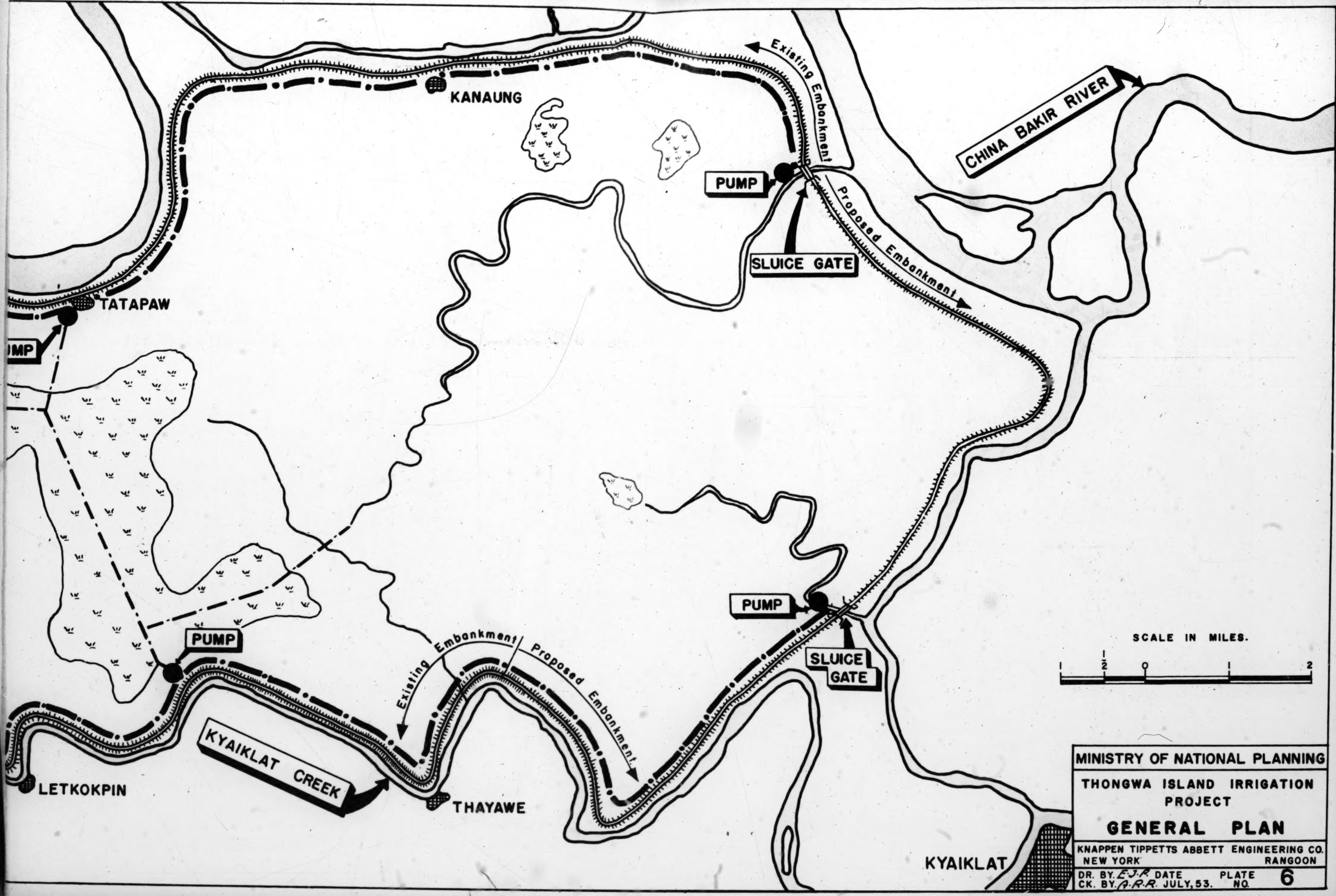
KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P DATE PLATE
CK. BY A.R.R MAY 53 NO. 5


Danbi
NEW CANAL
PUMP
HENZADA
IRRAWADDY RIVER
RAILWAY
Neikban
PUMP
ZALUN
A
Shage
Kyonsha
Anfaung
NEW CANAL
Thaunggyi
DANUBYU
Kyontani
Akyaw
YANDOON
Kyontama
Mezali
Chaunggyi
Kattiya
B
PUMP
Kywedon
Aukton
C
Malerto
MA-UBIN
Pantabu
PUMP
Letkokpin
D
Kanaung
SCALE IN MILES
5 0 5 10 15
LEGEND
Ⓐ ZALUN PUMP IRRIGATION DEVELOPMENT
Ⓑ YANDOON ISLAND " "
Ⓒ MA-UBIN PUMP " "
Ⓓ THONGWA ISLAND " "
LEVEE
LEVEE (New)
● PUMP


KOKKOSU
TOE RIVER
SLUICE GATE
EAST-CANAL
PUMP
P
DRAINAGE CANAL
PANTABUT
WEST-CANAL
MA-UBIN
ZAYATKON


E
KANAUNG
KOKKOSU
DE RIVER
EAST-CANAL
TATAPAW
PUMP
PUMP
SLU
DRAINAGE CANAL
PUM
WEST-CANAL
PUMP
Existing Embankment
Proposed Embankment
KYAIKLAT CREEK
ZAYATKON
LETKOKPIN
THAYAWE


KANAUNG
Existing Embankment
CHINA BAKIR RIVER
PUMP
SLUICE GATE
Proposed Embankment
TATAPAW
PUMP
PUMP
PUMP
SLUICE GATE
SCALE IN MILES.
1 1/2 0 1 2
Existing Embankment
Proposed Embankment
KYAIKLAT CREEK
LETKOKPIN
THAYAWE
KYAIKLAT

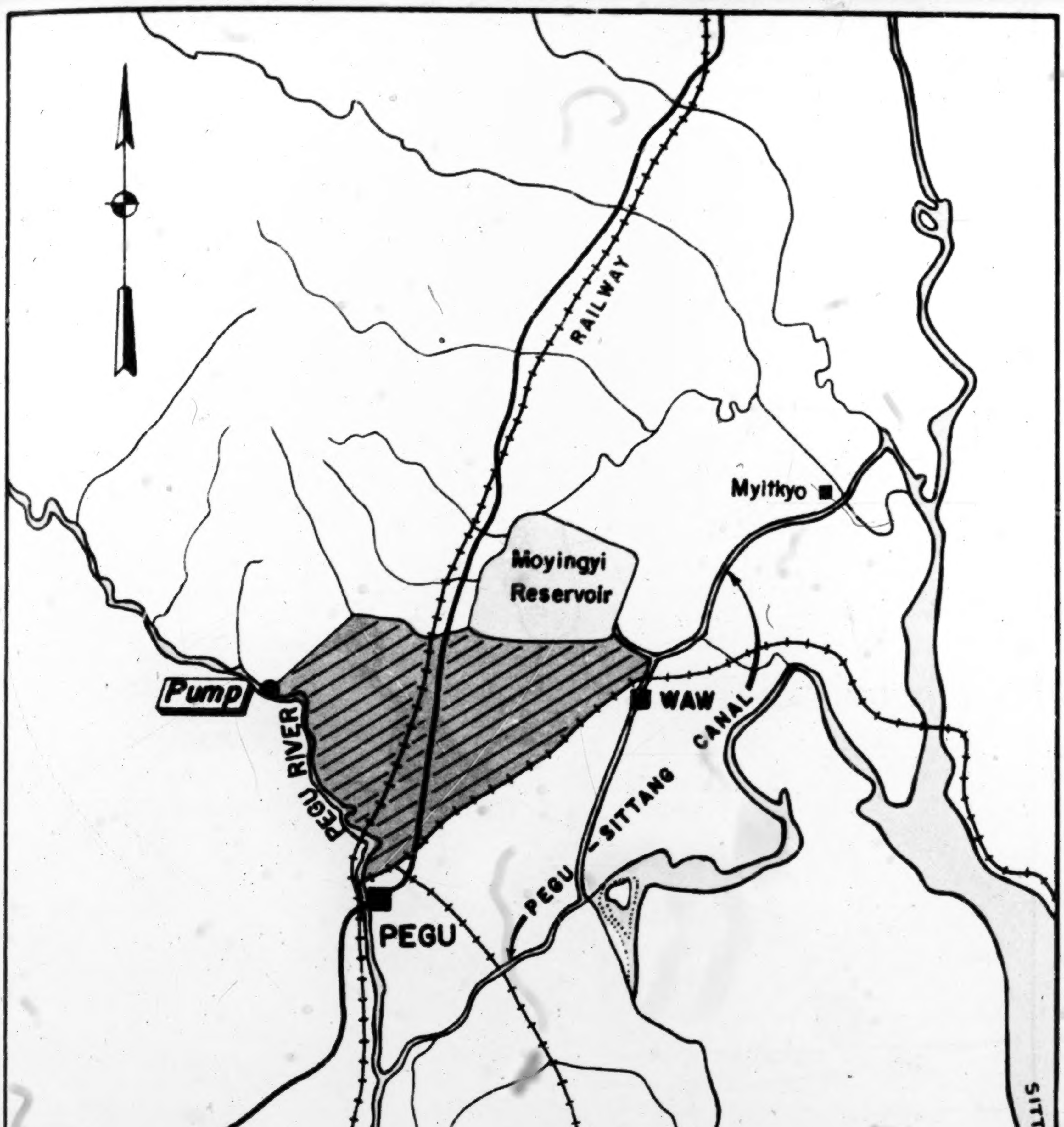
MINISTRY OF NATIONAL PLANNING

THONGWA ISLAND IRRIGATION PROJECT

GENERAL PLAN

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. E.J.R. DATE
CK. BY. A.R.R. JULY, 53.
PLATE NO. 6


RAILWAY
Myitkyo
Moyingyi Reservoir
Pump
WAW
PEGU RIVER
CANAL
PEGU - SITTANG
PEGU
SITTANG RIVER
SCALE IN MILES
5
0
5
10
15

MINISTRY OF NATIONAL PLANNING

PEGU AREA IRRIGATION DEVELOPMENT

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P. DATE PLATE
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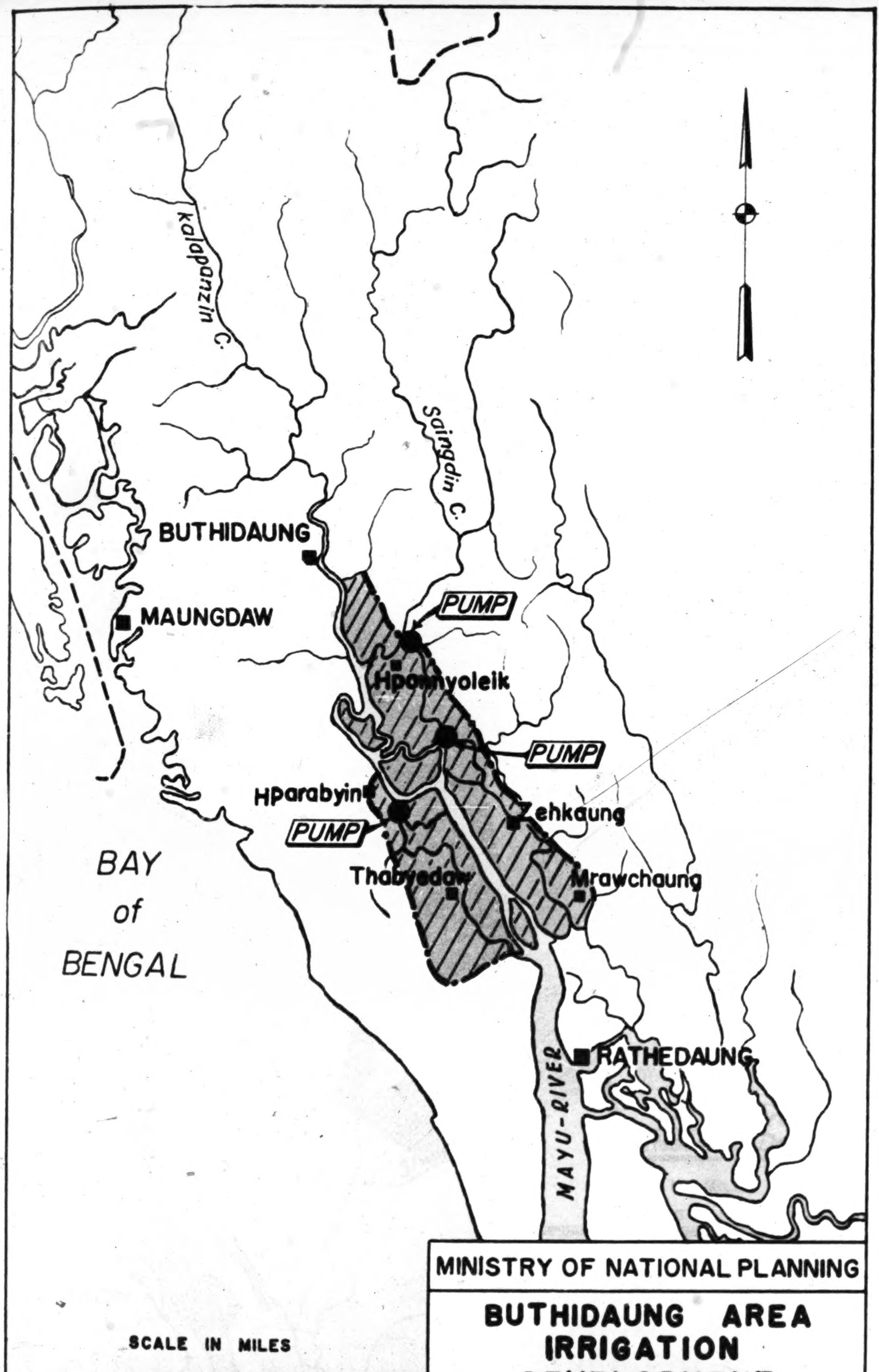
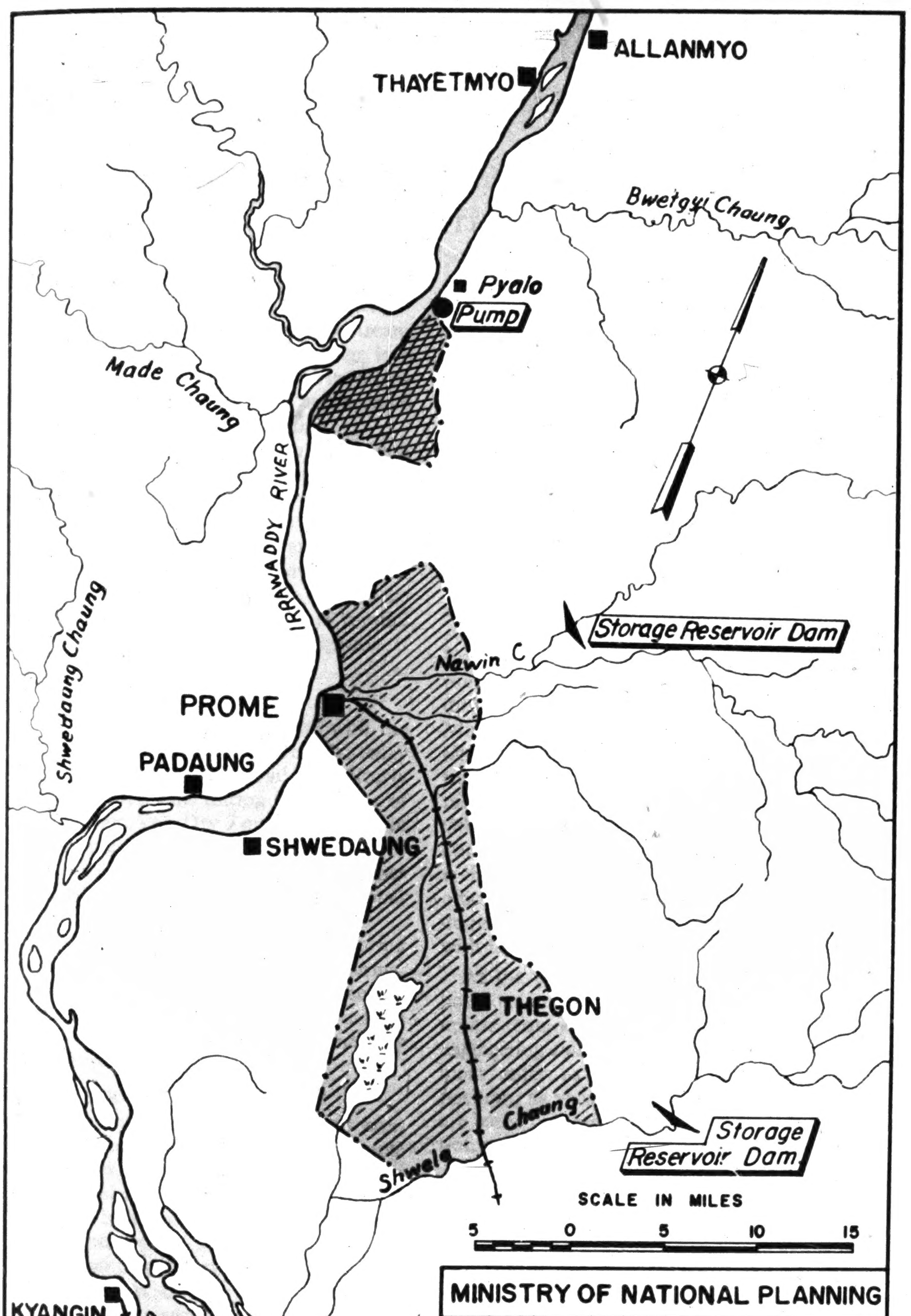

kalapanzin C.
Saingdin C.
BUTHIDAUNG
MAUNGDAW
PUMP
Hponnyoleik
PUMP
Hparabyin
PUMP
Zehkaung
Thabyedaw
Mrawchaung
BAY
of
BENGAL
RATHEDAUNG
MAYU-RIVER
SCALE IN MILES
5
0
5
10
15

MINISTRY OF NATIONAL PLANNING

BUTHIDAUNG AREA IRRIGATION DEVELOPMENT

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.R. DATE
CK. BY A.R.R. MAY 53
PLATE NO. 8


ALLANMYO
THAYETMYO
Bwetgyi Chaung
Pyalo
Pump
Made Chaung
IRRAWADDY RIVER
Shwedaung Chaung
Storage Reservoir Dam
Nawin C
PROME
PADAUNG
SHWEDAUNG
THEGON
Chaung
Shwele
Storage Reservoir Dam
KYANGIN
SCALE IN MILES
5
0
5
10
15

MINISTRY OF NATIONAL PLANNING

PROME AREA IRRIGATION DEVELOPMENT

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P. DATE PLATE
CK. BY A.R.R. MAY 53 NO. 9

CHAPTER IX

IRRIGATION

A. OVER-ALL IRRIGATION PROGRAM

"Irrigation" is the artificial supply of water to cultivated crops from a storage reservoir, by stream diversion or by pumping from wells. Drainage is a part of any irrigation development because land irrigated without a proper drainage system can become waterlogged and wasted for lack of aeration.

Irrigation of crops is not necessary in areas with sufficient rainfall for the crop requirements, provided the rainfall occurs at the time needed. Areas with adequate annual rainfall the occurrence of which is not at the times needed, will benefit from supplemental irrigation at those times during the growing season when the rainfall is deficient. Areas in which the growing season is entirely within the low rainfall period must be totally supplied from irrigation if there is to be a crop.

1. GENERAL

Rainfall is abundant in most of Burma, with the exception of the dry area south and west of Mandalay which represents about 40% of the total area. Nearly all the rainfall, however, falls during the months of May through October. The Dry Zone is deficient in moisture even during the rainy season, and areas of plentiful annual rainfall often suffer crop losses because the moisture does not occur at the proper time.

The average annual rainfall for all areas of Burma is shown on Plate 4 of Chapter I. In central Burma, irrigation from the water resource at hand is needed, and in lower Burma, water must be drained from the land as well as contained in the river channels by means of embankments.

2. PRESENT OPERATIONS

Irrigation, flood control and drainage have been practiced in Burma for many years. The early, simple works were originally managed by men elected from among those who benefited from the installations. Centralized control came into being but its activities were restricted to those works which could produce a profit, and the other small irrigation projects were left to the management of the local committees. Many of these fell into complete disuse and disrepair. A small percentage of all cultivated land in Burma is now under irrigation. Most of the irrigation projects are government owned.

a. Organization

An organization for the operation, maintenance and control of the irrigation works is a department of the Government of the Union of Burma under the Ministry of Agriculture and Forests. The organization chart for the Department of Irrigation is shown on Plate 1.

The functions and responsibilities of the positions in the organization, except those of Personal Assistant to the Chief Engineer and Works Officer, are described in the Public Works Department Code, Government of Burma, Volume 1 (First Edition) 1933, under which the department operates. The two specific positions excepted were created by special order. The Personal Assistant to the Chief Engineer assists the Chief Engineer in all matters as directed, including the preparation and control of the budget and expenditures, liaison between the department and the Ministry of Agriculture and Forests, and control of all Rangoon office staff including the draftsmen, tracers and designers who are also personnel under the Superintending Engineer, Delta Circle. The Works Officer is a special assistant to the Chief Engineer with duties in connection with new construction and revisions. He is the liaison officer between the field offices and the Chief Engineer, often acts as chief designer, and prepares special reports in connection with new proposals.

At the present time, new recruits for any of the positions in the Department from Assistant Engineer up are required to have a degree in engineering. New engineering college graduates accepted by the Department enter as Assistant Engineers. Advances in position, as vacancies occur within the Department, are based on period of service, provided the examination required under the code has been passed.

There has been very little need for design except for minor repairs. Design and drafting in the Rangoon office have been performed principally for special reports by the same staff employed under the Delta Circle, with technical assistance from those holding executive positions in the Rangoon office. Other construction or repair details have been prepared in the individual field offices as needed, often without the prior knowledge of the Chief Engineer's office in Rangoon.

The revenue staff, gate keepers, lock keepers, tracers, draftsmen, and clerks make up the balance of the permanent or semi-permanent employees. Survey parties are made up as needed, with the Sub-assistant Engineer or Assistant Engineer as the instrument man. The Revenue Staff includes canal surveyors, inspectors, and water-masters. The tracers and draftsmen are non-technical employees with a desire for that type of work.

The Department of Irrigation is charged not only with irrigation works but with flood control and drainage as well. In these fields of activity two canals, the Twante and the Pegu-Sittang, were constructed to transport agricultural products. This led to the assumption of navigation as one of the responsibilities of the Department. Operation and maintenance of the Pegu-Sittang and Twante Canals and the embankment work on the rivers necessitate the use of dredges and the maintenance of dredge crews as a part of the organization. The natural conditions and physical characteristics of the country divide the work of the Department into two distinct classifications; irrigation in Upper and Central Burma, and navigation, embankments and drainage in Lower Burma.

The Irrigation Department has always given technical assistance, within the limitations of its organization, to irrigation works managed by local village committees. This assistance has been made more effective by the establishing of Sub-division Officers for this purpose alone. The close contact of these officers with the particular villages involved has resulted in better cooperation, and many of the improved irrigation facilities have come through these contacts.

The supply of domestic water for the inhabitants in areas where canals exist is also a minor but vital role played by the Irrigation Department. Village tanks in Shwebo, Meiktila, Yamethin, Kyaukse and Mandalay districts get their supplies replenished from time to time from the irrigation canals. Mandalay, Meiktila, Yamethin and Shwebo now obtain much of their domestic supply from works managed by the Department.

b. Works

Although irrigation in the Dry Zone of Burma has been practiced for centuries, there are no extensive irrigation projects, and the supply of water is generally not dependable because there is no upstream storage for regulated supply. Water is supplied from natural stream flow diversion by low headworks and from numerous small storage tanks.

Early appreciation of the value of the plentiful water supply during the rains has resulted in the farmers using the simple means at hand for storage. The paddy fields with their many bunds provide this major storage, which probably accounts to a great extent for the mono-crop culture. This type of storage, however, is useful only for the crop growing within the bunds at the time of storage. The small storage facilities and the uncertainty of stream flow limit the present irrigation to supplemental supply during the rainy season only. Crop diversification is practically impossible, and cultivation of crops during the dry season is not the rule because dry weather irrigation is not practiced.

The cultivated land under irrigation and its location are shown in Table IX–1.

TABLE IX – 1

CULTIVATED LAND UNDER IRRIGATION

(1948)

1	2	3	4	5	6
Division	*Total Net Sown and Fallow (thousand acres)*	*Total Land Irrigated in 1948 (thousand acres)*	*Per cent of all Cultivated Land under Irrigation*	*Per cent of Total Irrigated Land*	*Govt.-Owned Irrigation Projects (thousand acres)*
Arakan	1,252	—	—		—
Pegu	4,430	74	1·7	5·6	0·6
Irrawaddy	4,180	47	1·1	3·5	—
Tenasserim	1,948	62	3·2	4·7	—
Magwe	2,792	187	6·7	14·1	111
Mandalay	3,086	534	17·3	40·2	345
Sagaing	3,500	423	12·1	31·9	287
Total	21,188	1,327	6·3	100·0	743·6

Some of the irrigation systems are supposed to date from earlier than the 9th century. The canal systems in the Kyaukse and Minbu districts are the oldest. The systems were improved by various Burmese kings and many of the works used today were built or improved by the kings as early as the 10th century. The Kyaukse irrigation area is often referred to in Burmese history, and was once known as the economic center of the north. The regular annual increase in the land area irrigated is an indication of the appreciation of irrigation and the knowledge of the artificial application of water for crop cultivation. The acreages irrigated annually under the various systems now in use are shown on Plate 2. The locations of present irrigation works and areas irrigated are shown on Plate 3, represented by the dark green color.

Government-owned irrigation systems are not the source of all the irrigation in Burma, as may be seen in column 6 of Table IX–1. Present data regarding most of those projects not government-owned are not available, and many of the areas were not visited because of the unrest in the country. Records available before the war were related to land revenue which was based on crop production. Most of these records have been destroyed, and not even the Irrigation Department has knowledge of the details of all the irrigation works.

Data relating to existing government-controlled irrigation projects are shown in Table IX–2. The data were compiled from the Administration Report of the Public Works Department Burma (Irrigation Branch) for the year 1939–40. Only the data of immediate interest are listed. More detailed information may be obtained from the Report.

Capital expenditures are all charges for the first construction and equipment of a project, charges for maintenance on sections not opened for operation, and charges for subsequent additions and improvements. Special rules apply in the case of renewals and replacements of existing works. The expenditures may include both direct and indirect charges which are specified as follows: works, establishment (surveys), and tools and plant, as direct charges; and capitalization of abatement of land revenue on area occupied by works calculated at 20 years' purchase, and audit on accounts charges at 1% on works outlay as indirect charges.

A brief description of the larger of the irrigation systems follows:

(1) Shwebo and Ye-U Canal Systems

These canal systems are fed from the Mu River by a diversion weir 455 feet in length constructed at Kabo. The Ye-U canal takes off on the right side of the river through a headgate structure with three Walton gates each 18 ft. 4 in. wide. The Shwebo canal takes off on the left side of the river through a headgate structure containing 20 gates of 5-foot diameter each. The diversion and headgate structures are integral, the diversion consisting of a masonry weir 455 feet in length provided with falling shutters, and two 30-foot-wide stony undersluice gates on the right end and four 40-foot-wide stony undersluice gates on the left end. The Shwebo canal system came into operation in 1906–07 and the Ye-U canal system in 1911–12.

(2) Mandalay Canal System

This system has its headworks at Sedaw on the Chaungmagyi River. The diversion consists of a masonry weir 310 feet in length with a subsidiary weir 500 feet long and an 80-foot-long undersluice at one end with the Mandalay canal headworks of 12 sluice gates, each 5 ft. 6 in. wide. Another structure of note is the aqueduct for the entire canal capacity across the Thapangaing Chaung for a length of 264 feet. Each side of the aqueduct is fitted with shutters, and when the chaung is in flood these are dropped, the canal is closed, and the chaung flows both over and under the structure. The Mandalay canal system came into operation in 1902–03.

(3) Zawgyi River System

These irrigation works in Kyaukse District consist of five separate canals, the Nwadet Canal, Ngapyaung Canal, Thindwe Canal, Minye and Tamok Canals, and the Zidaw Canal. They were originally constructed during the days of the Burmese kings, and were later remodeled with modern masonry weirs constructed during the last part of the last century at an expenditure of approximately K23,77,000.

(4) Paunglaung River System

These irrigation works, also in the Kyaukse District, consist of four separate canals, Kinda Canal, Nathlwe Canal, Kyime Canal and Htongyi Canal. Like the Zawgyi River System, they were originally constructed during the days of the Burmese kings and later remodeled at a cost of approximately K21,48,000.

(5) Salin Canal System

This system is of more recent origin, operating originally in 1925–26. It is the last of more than a dozen canals on the Salin Chaung. The smaller systems, all located above, have older water rights, and except for the Khine Canal, are not under government control. The upper canals serve approximately 3,000 acres.

The diversion weir across the Salin River near Linzin is an overfall type ogee section of concrete, 750 feet in length with two undersluice gates each 60 feet wide. The headgate structure of three sluice gates, each 20 feet wide, serves the canal on the right side of the river. Little water reaches the headworks at low river flows. The Khine Canal headgate structure, three miles above Linzin, is somewhat of a temporary structure, and requires constant attention.

(6) Mon Canal System

The diversion weir across the Mon River serving canal systems from either bank of the river, is located at Mezali. The headworks consist of a weir 838 feet long, with 4-foot-high automatic falling shutters, one undersluice gate on the north side and two on the south side, each 40 feet in width. The canals are supplied through a headgate with three sluice gates on the north and a headgate with four sluice gates on the south, each gate 5 feet wide. Supplies of water are usually more than ample to meet the canal requirements. Passage of log rafts is allowed twice weekly. These irrigation works first came into operation in 1911–12.

TABLE IX – 2

PRESENT IRRIGATION IN BURMA

Government Control (1939–40 Report)

1 *Name of Works*	2 *District Location*	3 *Water Supply Source*	4 *Minimum Flow Recorded (c.f.s.)*	5 *Canal Design (c.f.s.)*	6 *Irrigated Area Rainfall*	7 *Gross Acres Commanded*	8 *Acres Irrigable*	9 *Acres Irrigated*	10 *Canal Miles* *Main and Branch*	11 *Distributaries*	12 *Capital Outlay to Date** *Total K*
Shwebo Canal	Shwebo	Mu River	9·36	2,624	34·65	264,129	229,815	211,717	70·51	334·71	76,08,869
Mandalay Canal	Mandalay	Madaya River	177·00	1,576	33·69	132,696	126,641	92,061	67·70	132·80	66,04,319
Mon Canal	Minbu	Mon River	Not known	576	34·02	29,518	28,769	21,544	20·55	44·23	12,01,761
Zawgyi River System											
Nwadet Canal	Kyaukse	Zawgyi River	174·00	530	31·53	37,617	29,413	24,433	30·50	67·78	8,64,524
Ngapyaung Canal	,,	,, ,,	174·00	100	31·53	8,600	5,200	4,106	7·50	7·50	1,32,817
Thindwe Canal	,,	,, ,,	174·00	170	31·53	17,000	14,900	10,595	14·70	16·20	1,95,609
Minye and Tamok Canals	,,	,, ,,	174·00	380	31·53	33,250	23,400	20,054	21·60	36·70	2,11,025
Zidaw Canal	,,	,, ,,	174·00	911	31·53	48,000	41,100	5,231	21·14	39·44	9,08,402
Paunglaung River System											
Kinda Canal	,,	Paunglaung River	244·00	900	30·65	53,000	42,400	36,193	42·20	69·97	13,40,877
Nathlwe Canal	,,	,, ,,	244·00	282	30·65	20,600	16,480	10,476	10·50	35·21	2,25,520
Kyime Canal	,,	,, ,,	244·00	600	30·65	42,189	33,751	25,264	24·70	24·90	4,77,648
Htongyi Canal	,,	,, ,,	244·00	80	30·65	4,570	3,656	2,646	7·50	—	92,849
Ye-U Canal	Shwebo	Mu River	9·36	1,765	35·15	145,482	128,900	107,433	63·70	192·50	62,18,863
Old Mu Canal	,,	†	—	—	36·27	58,000	19,500	8,789	23·00	—	—
Mon Canals	Minbu	Mon River	160·00	1,382	35·28	125,309	119,822	79,140	53·80	163·50	78,22,678
Salin Canals	,,	Salin River	—	670	32·30	—	29,700	21,406	21·70	54·40	41,72,504
Khine Canal	,,	,, ,,	—	—	32·30	2,680	—	1,568	3·00	—	—
Inyin Canal	Meiktila	Thinbon Chaung	—	430	30·00	20,046	10,813	5,735	3·25	—	—
Tanks			*Drainage Area (sq. mi.)*	*Capacity (ac. ft.)*							
Meiktila Lake	Meiktila	Drain Area Flow-off	240·00	19,300	33·45	66,066	55,485	42,437	—	18·74	9,38,351
Nyaungyan and Minhla Tanks	,,	,,	540·00	13,500	37·14	34,330	27,302	27,239	—	35·41	15,56,344
Kyaukse Tank	Yamethin	,,	187·00	15,500	35·20	8,521	8,122	5,310	—	8·65	5,89,222
Taunggon Tank	Mandalay	Thapangaing Chaung	126·00	1,670	37·99	7,879	6,286	2,446	6·80	11·70	—
Htonbo-Sedaw System	,,	Nadaunggya Chaung	139·00	—	33·90	7,044	5,636	2,570	3·40	7·20	—
Kana Tank	Myingyan	Drain Area Flow-off	91·00	6,850	32·71	9,300	7,440	4,168	4·72	—	—
Pyogan Tank	,,	,,	89·00	460	29·58	4,073	3,258	1,019	—	—	—
24 Minor Irrigation Works	Meiktila	,,			31·37	100,844	80,675	30,725	—		—
13 Minor Irrigation Works	Yamethin	,,			35·84	62,393	56,559	36,563	—		—

*Amounts shown are prewar value. †Originally, the Mu River, now the various chaungs across which it runs.

(7) Man Canal System

The water supply for this canal system is from a masonry weir across the Man River at Aingma. This weir was originally of stone but was replaced by a similar structure of stone surfaced with concrete. The crest length is 400 feet and is approximately 300 feet downstream from the canal headgate. Coarse gravel enters the canal causing a gradual reduction in the capacity. The water supply in the river is not assured, therefore rotation of service is common.

(8) Other Minor Irrigation Works

Irrigation from tanks or reservoirs is also practiced over a wide area in addition to the irrigation by canals from the various stream diversions. These systems consist essentially of a tank or reservoir provided with suitable outlets to supply controlled water to a network of canals. The runoff from the rainfall in the catchment area of the stream feeding the tank is stored and released when required. The largest of these works is the Meiktila Lake which was originally constructed by the Burmese kings and later modernized with masonry outlets and escapes at a cost of approximately K9,39,000. Another large tank system is the Nyaungyan-Minhla Tank System which was constructed at a total cost of approximately K15,56,000. Numerous other small tanks may be found throughout Burma. The area irrigated from these supplies is limited by their small storage capacities and location.

Silting of the tanks has been very rapid, Meiktila Lake receiving 8 million cubic feet annually and the Nyaungyan-Minhla Tank receiving 11 million cubic feet annually. It is said that this silting did not occur until cultivation was practiced in the drainage area supplying these reservoirs, a practice that was not allowed in the time of the Burmese kings.

(9) Old Mu Canal

The irrigation system under this canal is of great historical importance and deserves mention because of its relation to a future irrigation development to be discussed later in this report. Just when the old Mu Canal was originally constructed has not been ascertained, but it is apparent that one of the Burmese kings used it to supply water to Shwebo. The original diversion works were constructed across the Mu River at Wetto but they were destroyed and never rebuilt. Continued difficulty with the upper end of the canal because of the large drainage courses through which the canal runs has been a factor in the delay in re-establishing the system to its original use. Many of the canal gate, control and drainage structures are maintained, and lands are irrigated from the canal and from the tank at the southerly end of the canal. The present water supply amounts only to that flowing into the canal from the chaungs across which it runs. Assured supply from the canal is definitely limited.

(10) Twante Canal

This canal was constructed and is maintained by the Department for the transportation of essential produce, especially of rice and timber from Upper Burma. It is 21 miles in length, connecting the Rangoon River and the China Bakir River. The total cost was approximately K1,03,96,000. The canal came into operation in 1916–17.

(11) Pegu-Sittang Canal

This canal connects the Pegu and Sittang Rivers, permitting transportation to Rangoon from the Pegu District without necessitating passage via the open sea. It is 38 miles long with canal locks at each end to compensate for the water level variations between the canal and the rivers. To augment the water supply in the canal during the dry season, the Moyingyi Reservoir was constructed to store rainfall runoff. The total cost of the complete construction was approximately K79,46,000.

(12) Embankment Works

Embankments which protect over 1,150,000 acres of cultivated land were constructed and are maintained by the Department in the Delta and on the Irrawaddy and Sittang Rivers, and River Training Works in the Pyuntaza Plain. The individual works are these:

Name		*Area Protected*	
Irrawaddy Embankments		755,974	Acres
Maubin	,,	142,808	,,
Thongwa	,,	32,275	,,
Sittang	,,	52,434	,,
Yandoon	,,	57,616	,,
Tamatakaw	,,	13,253	,,
Ela	,,	5,155	,,
Belin	,,	3,263	,,
River Training Works in Pyuntaza Plain		116,072	,,
		1,178,850	,,

c. Field Control

The water distribution is maintained by the Irrigation Department from the main and branch canals and distributaries only. The distribution system to the individual farm plots has been constructed and is maintained by the farmers themselves. Assistance is given by the canal inspectors of the Department so that the supply of water will be economically and fairly distributed. Most of the farm services are uncontrolled openings, the supply maintained by holding the water in the canal at a constant level. Turnout structures to these farm areas may release as much as 15 c.f.s. for distribution by the group under the turnout. All canal structures down to and including those supplying such services are of masonry or concrete construction with steel fabricated or iron gates. The operation of all gates is by hand and quite efficient in most instances except for time required in opening and closing them. The falling shutters at some of the weirs are raised by hand, a procedure in which the operator stands in water behind a raised shutter preceding the shutter he is raising or lowering. Quite often the sluice gates must be opened ahead of time to relieve the flow over the weir so that the shutters may be raised or lowered. None of the main, branch or distributary canals is lined. Several of the canals inspected are in need of realignment, reconstruction and lining. Many canal bank slopes are too steep and the berms too narrow.

The distribution systems serving individual plots and ownerships are essentially a series of hand dug canals and water courses maintained and modified from time to time by the farmers to fit their needs. Most of the structures are of stakes and mud with an occasional permanent structure in the more important laterals. It is not uncommon to see excess water adjacent to the fields since the supply is dependent on rainfall and therefore usually too plentiful at the wrong time.

Maintenance equipment of the Irrigation Department for irrigation works consists principally of cement mixers, dump trucks, welding units, compressors, pumps, workshop equipment, jeeps and inspection cars. Most work is by hand, materials being hauled in head baskets or trays and by bullock-cart. A large force is maintained for this purpose. Within the last two years, heavy construction equipment has been purchased, and it is understood that more is on order. The heavy equipment on hand at this time consists of two Tournadozers, four Terra Cobra scrapers and four dozers, two of which are D8 and two of which are TD10.

3. FUTURE IRRIGATION DEVELOPMENTS

The water resources from stream flow are abundant throughout most of Burma, as shown in Chapter I. Most of the supply is wasted, however, because it occurs in the rainy season of the year, and the storage facilities are sufficient for only a very minor percentage of the total.

The status of agricultural land in the Dry Zone in regard to acres under irrigation and cultivation is shown in Table IX–3. Other data included under Agriculture in Chapter VIII show that present production is low, much land in the Dry Zone is left fallow and abandoned because of lack of water, other lands suitable for agriculture are not cultivated because of the lack of moisture, and crops are not grown during the dry season on a significant scale. This loss in full utilization of the land potential is a tremendous factor in the economic life of the country.

TABLE IX – 3

STATUS OF AGRICULTURAL LAND

District	*Acres, Irrigated*	*Acres, Dry Crop*	*Acres Suitable for Agriculture not Cultivated*
Lower Chindwin	110,400	804,300	343,000
Sagaing	55,100	796,500	141,000
Pakokku	116,500	762,600	452,000
Shwebo	628,300	491,400	350,000
Magwe	116,000	1,010,900	208,000
Myingyan	58,200	1,131,200	157,000
Meiktila	20,800	684,400	226,000
Yamethin	302,200	335,400	769,000
Kyaukse	140,200	134,700	65,000
Minbu	150,500	331,600	120,000
	1,698,200	6,483,000	2,831,000

It is evident that a liberal use of the available water supplies for irrigation in the lower Delta during the dry period would add materially to the welfare of the area through increased production, a wider variety of products for home consumption, more diversified crops, and a fuller utilization of labor during the slack periods caused by a one-crop economy.

The Preliminary Report proposed pump irrigation in the Delta area for the dry season only. Due to the excessive moisture during the rainy season, rice is the only crop that can be grown. During the dry period from December to May, the land is so hard that it is impossible to cultivate for any production without water. Location for pump installations and irrigation development will depend on experimental installations, ground-water tests for supply, water table elevation and salinity, stream tests for salinity, and soil tests for pH and crop capabilities. Only those areas best suited and satisfactorily passing the requirements in the before-named tests should be developed. A program of land classification surveys such as proposed in Chapter VIII is prerequisite to the proper determination of suitable lands.

Future irrigation development planning may be evaluated on the basis of benefits that would accrue from increased production by supplying water for crops in areas of low rainfall and low incomes because of dry farming; for a second crop during the dry season in geographically suited areas; for supplemental moisture as needed for crops in certain areas during the rainy season; and for stabilizing the water supplies by the construction of storage reservoirs to store the water now uncontrolled and wasted.

Future irrigation development projects proposed herein have been predicated on use of the underground water resources by pumping from wells, gravity diversion from streams, or by pumping, or gravity diversion from streams regulated by storage dams proposed solely for irrigation purposes or in conjunction with hydroelectric power generation.

a. The Program

The planning of the future irrigation developments includes classification of the projects into a development program for Early Implementation, Near Future Consideration, and Far Future Consideration as shown in Table IX–4. The location of the projects is shown on the Location Maps, Plates 3 and 4. The listing in Table IX–4 is in order of priority. Although other irrigation developments may be feasible after a period of economic development, those listed and discussed here are considered most worthy at this time. The last four under "Far Future Consideration" are discussed very briefly.

(1) Early Implementation

Projects listed for early implementation are those deemed most suitable for construction within the next ten years. The classification is based on the benefits from increased production to the country and the particular area, and the economic feasibility and correlation in the over-all development plan for Burma. Estimated capital cost, annual charges, and benefits are discussed in Section C of this chapter and shown in Table IX–19. The individual projects are discussed in detail under "Specific Projects," briefly summarized as follows:

(a) Mu River irrigation project. The development of this river for irrigation was recommended for future study in the Preliminary Report, and was low on the priority list for construction. Studies which followed disclosed this project to be the most outstanding of all developments considered.

The area lying in the triangle formed by the Chindwin and Irrawaddy Rivers, from their confluence north to Wetto, is a vast acreage suitable for agriculture, nearly all of which is accessible for irrigation from the Mu River. Approximately 265,000 acres of the area are irrigated now under the Shwebo and Ye-U Canals, but only by river-run diversion and as a supplement during the rainy season. Lands are also irrigated under the old Mu Canal but only from a limited water supply stored from small drainage area runoff.

The Mu River irrigation project will irrigate over 1,100,000 gross acres for supplement during the rainy season plus total requirements for a second crop in the dry season. Installation of power generation equipment in conjunction with the irrigation development will produce low-cost power for pumping from the Chindwin and Irrawaddy Rivers south as far as Seikpyu. This pump irrigation is also included as a unit of the Mu River Project, adding an additional 330,000 acres.

Table IX – 4

FUTURE IRRIGATION DEVELOPMENTS

Early Implementation	*Location by Districts*
Mu River Irrigation Project	Shwebo, Sagaing, Lower Chindwin, Myingyan, Pakokku and Minbu
Yamethin District Irrigation Project	Yamethin and Toungoo
Kandaw Village Irrigation Project	Pakokku
Loikaw Area Irrigation Project	Kayah State
Near Future Consideration	
Thongwa Island Irrigation Project	Ma-Ubin
Meiktila Lake	Meiktila
Pakokku Pump Irrigation from Wells	Pakokku
Far Future Consideration	
Pegu Area Irrigation Development	Pegu
Ma-Ubin Pump Irrigation Development	Ma-Ubin
Buthidaung Area Irrigation Development	Arakan
Yandoon Island Irrigation Development	Ma-Ubin
Henzada-Zulun Pump Irrigation Development	Henzada
Prome Area Irrigation Development	Prome
Mon River Irrigation Project	Minbu
Yanbe and Yin River Irrigation Development	Magwe
Myitnge, Myittha, Shweli and Irrawaddy Rivers Development Projects	Kyaukse, Lower Chindwin, Bhamo and Myitkyina

(b) Yamethin District irrigation project. This project is the outgrowth of a project report prepared by the Department of Irrigation, for the development of the Sinthe Chaung in the Yamethin District. It was proposed in the Preliminary Report for the irrigation of approximately 78,000 acres from a storage reservoir at a high elevation to reach lands in the vicinity of Yamethin. Detailed studies of the project resulted in a much more feasible project based on the development of all the water resources in the upper valley of the Sittang River of which the Sinthe Chaung is a tributary.

The over-all project contemplates the development and economical use of the water supply from the Thitson, Shweda, Sinthe, Yezin, Ngalaik, Saing and Swa Chaungs, the Paunglaung River, and the Myaungmadaw Canal–Kyeni Tank installations. Each development may initially be considered as an independent unit for stage construction with final interconnection of several of the stages for distribution of total costs over a larger area. Of the 609,450 gross acres to be supplied with irrigation water from reservoirs on each of the units listed above, 400,250 acres are in the Yamethin District and 209,200 are in the Toungoo District.

The basic characteristics of the general layout are the location of supply canals at the foot of the hills on each side of the plains area and dams where the streams emerge on the plain so that high reservoirs can serve the canals. Although the main source of water supply is from these surface streams, the project includes the tapping of the underground water supply from which the water will be pumped to the land. The underground supply is to serve an area near the extreme northerly headwaters of the Sittang River east of the Nawin Chaung from Tatkon Village north to the Shweda Chaung.

Irrigation from minor works now operating in the area and installations to conserve and use the water supply as it is now available will be improved and incorporated in the project. The plains area between the Shan Hills on the east and the Pegu Yomas on the west will be benefited by an assured supply, not only supplemental during the rainy season crop period, but also for a second crop during the dry season.

(c) Kandaw Village irrigation project. This project was not considered in the Preliminary Report, but the area that will be benefited was a part of the total area of the Pakokku pump irrigation proposal. The reconstruction of an old embankment, which dates back to the same period as the original Meiktila Lake construction, will form storage facilities for all the runoff from a small stream drainage area. The tank thus formed will be near the north edge of Kandaw Village. The old system has been out of operation longer than anyone can remember, the embankment having breached soon after the original construction. The area to be irrigated under the project is adjacent to the village on the east and extends south to the Irrawaddy River. The soil is well suited for growing groundnuts, but because of the low rainfall, production is low and uncertain. The water stored in the tank will also be of great benefit for domestic use to several small villages around the tank perimeter.

(d) Loikaw Area irrigation project. Lack of detailed maps and field surveys has limited the study of areas for irrigation in the States outside of Burma proper. The lower part of the Yaunghwe Valley, in which Loikaw is the principal town, was visited and found to be topographically suited for irrigation. The project was not included in the Preliminary Report, but studies carried out since that time have placed it high on the priority for development.

The Balu Chaung flows nearly the full length of the valley from Inle Lake at the north end. This natural resource presents excellent possibilities for irrigation development. Small systems are now in operation in the valley so that cultivators with the water supply realize the use of irrigation. The water supply in the river is sufficient the year round if regulation and the means of raising it to the land are provided.

(2) Near Future Consideration

Projects listed for near future consideration are those which would be considered economically feasible after advance has been made in operation and construction techniques, the country is more settled, individual incentives demand more development, and other project developments have been completed. In some instances the development of hydroelectric installations to provide cheap power would be a factor in establishing the economic justification of the project under this classification.

Estimated capital cost, annual charges and benefits are discussed in Section C of this chapter and shown in Table IX–19.

(a) Thongwa Island irrigation project. This project is a unit of the Lower Delta pump irrigation development listed in the Preliminary Report. Its location is shown in Plate 5 and a general plan of the project is shown on Plate 6. The area to be benefited is surrounded entirely by streams and protected by levees on all but the southerly side. The project includes the addition of 12 miles of levee to close the ring, installation of drainage and flood gates at the upper and lower sides of the island, construction of a drainage canal through the low area and irrigation canals on the high perimeter, and installation of pumps for irrigation from the streams.

The sluice gates will be closed when the surrounding streams are too high for gravity flow, and the drainage pumps will discharge over the levee. The exact amount of the drainage that will require pumping cannot be determined without more data but it is estimated that it will amount to about 30% of the annual rainfall. The balance will run out by gravity, be used for irrigation or lost by evaporation, transpiration, and percolation.

The irrigation pumps will be installed to pump either from the drainage canals or the surrounding streams to the high land which cannot be reached by gravity flow. Gravity flow irrigation will be possible under certain conditions from the drainage canal with the upper sluice gate open. Control structures will be constructed in the drainage canal for this operation. It is estimated that pumping will be necessary for only one third of the water supply required for irrigation.

(b) Meiktila Lake. Meiktila Lake has been silting in at a rapid rate. The inflow is from a drainage area made up of broken low hills with sparse vegetation. Some of the area is under cultivation which no doubt adds to the heavy silt content of the inflow. The spillway facilities have been increased from time to time because of the decrease in storage capacity of the lake, and the dependability of the irrigation has been reduced by the decrease in water supply.

The capacity (Table IX–5) for the years 1896, 1923 and 1936 shows the amount of silting at various water levels in the two divisions of the lake. Reports on the rate of silting after 1936 show 8 million cubic feet annually.

TABLE IX – 5

MEIKTILA LAKE CAPACITY

(in acre feet)

SHOWING RATE OF SILTING

(Drainage Area 240·5 sq. miles)

1	2	3	4	5	6	7	8	9
Level	*South Lake*		*North Lake*			*Combined Lakes*		
	1896	*1923 and 1936*	*1896*	*1923*	*1936*	*1896*	*1923*	*1936*
725	7	7	—	—	—	7	7	7
730	90	90	—	—	—	90	90	90
735	315	315	—	—	—	315	315	315
740	1,055	1,055	—	—	—	1,055	1,055	1,055
745	2.510	2,510	195	2	—	2,705	2,512	2,510
747	3,310	3,310	556	43	10	3,876	3,353	3,320
748	3,755	3.755	838	130	55	4,593	3,885	3,810
749	4,240	4,235	1,220	280	145	5,460	4,515	4,380
750	4,760	4,745	1,747	525	300	6,507	5,260	5,045
751	5.325	5,295	2,433	875	530	7,758	6,170	5,825
752	5,935	5,885	3,248	1,415	885	9,183	7,300	6,740
753	6.592	6,520	4,178	2,110	1,285	10,770	8,630	7,805
754	7.301	7,205	5,213	2,910	1,830	12,514	10,115	9,035
755	8,063	7,950	6,353	3,810	2,500	14,416	11,760	10,450
756	8.888	8,775	7,588	4,728	3,300	16,476	13,503	12,075
757	9.803	9,690	8,902	5,744	4,200	18,705	15,434	13,800
758	10,823	10,710	10,377	6,906	5,195	21,200	17,616	15,905
759	11,970	11,840	11,992	8,186	6,270	23,962	20,026	18,110
760	13,238	13,090	13,752	9,616	7,440	26,990	22,706	20,530
761	14,634	14,470	15,667	11,136	8,740	30,301	25,606	23,210
762	16,169	15,970	17,732	12,916	10,210	33,901	28,886	26,180
763	17,791	17,580	19,937	14,861	11,900	37,728	32,441	29,480
764	19,496	19,285	22,280	16,917	13,840	41,776	36,202	33,125
765	21,301	21,080	24,765	19,167	16,020	46,066	40,247	37,100
766	23,201	22,950	27,388	21,562	18,370	50,589	44,512	41,320
767	25,181	24,880	30,143	24,092	20,975	55,324	48,972	45,755
768	27,231	26,870	33,043	26,772	23,535	60,274	53,642	50,405
769	29,351	28,930	36,083	29,602	26,355	65,434	58,532	55,285
770	31,545	31,070	39,258	32,582	29,335	70,803	63,652	60,405
771	33,801	33,290	42,571	35,727	32,480	76,372	69,017	65,770
772	36,129	35,595	46,016	39,032	35,785	82,145	74,627	71,380
773	38,539	37,995	49,601	42,497	39,250	88,140	80,492	77,245
774	41,031	40,485	53,326	46,127	42,880	94,357	86,612	83,365
775	43,621	43,075	57,186	49,917	46,670	100,807	92,992	89,745

Note: The above capacities have been entirely recalculated from the original surveys.

The embankments and the control structures have been in use for many years. The investment would be of greater value with the silt removed to increase the storage capacity of the lake and permit an increase in the acreage irrigated. The increase in stored water would also stabilize the annual supply over a period of several years by a carry-over of stored water to balance out the dry year cycle.

The removal of the existing silt deposit in Meiktila Lake is only one part of the plan for the development. A program for the relocation of cultivators from the drainage area, and a system of replacing the vegetable cover must be diligently implemented so that the land erosion and silt movement into the reservoir will be virtually eliminated. As was mentioned previously regarding the lake, under the Burmese kings cultivation in the drainage basin area was prohibited, and it was not until after settlement was allowed in the area that silt was deposited in the reservoir in such quantity. Continual removal of the silt deposited at the present rate would involve a great annual expense.

The acreage irrigated annually from Meiktila Lake and the total annual rainfall are shown in Table IX–6 for the years 1926–27 to 1939–40 and 1946–47 to 1951–52. It may be noted from these records that the acreage irrigated increases with the rainfall. This is substantiated by reports from the Department of Irrigation which state that the increases result from favorable rains. The time of year of the rainfall would also be a factor, but an increase in storage capacity of the lake would provide regulation for all conditions over a period of years. The record after 1947–48 is unreliable because of the unrest in the area.

TABLE IX – 6

ACREAGE IRRIGATED ANNUALLY
MEIKTILA LAKE SUPPLY

Year	Area Irrigated (acres)	Annual Rainfall (inches)
1926–27	46,893	55·37
27–28	43,024	43·81
28–29	24,002	30·51
29–30	30,920	27·43
30–31	33,172	45·40
31–32	30,516	26·41
32–33	32,925	28·90
33–34	38,401	38·38
34–35	28,201	34·43
35–36	32,891	49·18
36–37	29,433	26·63
37–38	46,137	51·07
38–39	41,640	36·93
39–40	42,437	—
46–47	31,101	30·37*
47–48	32,595	41·22
48–49	29,587	27·75
49–50	29,547	26·20
50–51	29,191	46·04
51–52	27,770	34·43

*From 1st June.

Several methods may be used in removing the silt from the lake. Large earth-moving wheel machines, drag lines and trucks could work in the dry area, bullock-carts and hand labor could assist in silt removal in both the dry and semi-dry areas, and a small dredger could complete the work in the wet area. A plan of procedure using any one or all of these methods could be developed for immediate implementation. The removed silt could be deposited on the land outside the embankments and existing water in the lake could be held out of the excavation area by leaving a portion of the silt for a dike or ring embankment. The work would be done on the North Lake only, programming the operation over a period of years. Further study and explorations are required to finally determine the most advantageous solution. Such studies should include determinations of silt location and degree of saturation and should include an examination of the possibility of raising the embankments instead of removing the silt.

(c) **Pakokku pump irrigation from wells.** This project has not been adequately studied for technical feasibility because of insufficient data on the underground water resources in the area. Tests made on the soil, however, indicate it to be above average for oil crop production. The provision of supplemental moisture and nitrogen fertilizer is all that is necessary to obtain high production in groundnuts and sesamum.

The topography of the area is not suited to a large single project, but if the underground water resources are found to be adequate, small well installations can be made at each of the areas that are now under cultivation on the ridges. Cheap power should be available for this development, but exploratory investigations and test wells could be started immediately, using diesel power for the first installations.

The estimated capital cost, annual charges and benefits shown in Table IX–19 are based on one installation for each 40 acres; the well 300 feet deep, cased and perforated as required; the pumping head 20 feet; and benefits from one crop per year.

(3) Far Future Consideration

The existence of the necessary physical requirements such as natural water resources and agricultural lands topographically suited to irrigation, made the projects under this classification worthy of future study and survey for the total irrigation development program. Any of those listed could provide production increases by supplying water for crops or providing drainage and reclamation facilities. Since not all projects can be constructed at one time, these have been scheduled for the time when development in other areas more in need will have been completed and greater production is desired. Estimated capital cost, annual charges and benefits are discussed in section C of this chapter and shown in Table IX–19. The details of costs and benefits are for the first five projects only. The others are considered to be too far in the future for such detailed planning.

(a) **Pegu Area irrigation development.** This development may be considered as another of the units of the Delta pump irrigation project proposed in the Preliminary Report. The General Location Plan is shown on Plate 7. This project would benefit an area in the vicinity of Pegu by pumping from the Pegu River into a distribution system starting approximately ten miles above Pegu. The provision of pumping rather than gravity diversion is determined by the low initial cost and the freedom from log rafting requirements. Sufficient flow will be assured in the river at all times by the construction of the proposed hydroelectric project approximately 30 miles upstream from the diversion works. Low-cost power will also be available from the hydroelectric project for the pump power.

(b) **Ma-Ubin pump irrigation development.** This development is another unit of the Delta pump irrigation development, the over-all general plan of which is shown on Plate 5. Map studies of the area indicate it to be geographically suited for such a development. Pumping is proposed from the Irrawaddy River. Although the tests enumerated heretofore as necessary for Delta pump irrigation development have not been made, it is reasonably safe to assume that the water supply for this unit is sufficiently fresh for use on the land. Drainage conditions appear to be excellent. The area lies in the triangle between the Irrawaddy and China Bakir Rivers and is well protected from overflow.

(c) **Buthidaung Area irrigation development.** Studies in conjunction with the Saingdin River Falls hydroelectric project have resulted in a feasible proposal for irrigation development in the Mayu River valley south of Buthidaung. Preliminary designs and layouts from map study indicate that the possibilities of the development are well established. Field surveys have not been made.

It is estimated that approximately 600,000 acre feet of water will be released from the hydroelectric development reservoir during the dry season. Existing water courses on both sides of the Mayu River just south of the mouth of the Saingdin Chaung furnish excellent storage and supply canals. The development proposes the construction of gated dams at the mouth of these chaungs with pumping installations from the Saingdin Chaung and Mayu River for the water supply. Water may be supplied to the land on both sides of the storage canals either by low pump lifts or gravity flow. Pumping heads are estimated to be from two feet to eight feet. Amount of land to be irrigated would be at least 100,000 acres, the actual amount depending on the distance south the development area would be extended.

Continued study will determine more exact details of the project and the economic benefits that may be derived therefrom. General details are shown on Plate 8.

(d) **Yandoon Island irrigation development.** This development is another unit of the Delta pump irrigation development. The area is an isolated piece of land surrounded entirely by streams and protected by levees on all but the extreme southerly and easterly sides. A large part of the area is swampy with elevations below sea level at some locations. A part of the area is now being cleared, and gates have been installed at the upper end for silt recharging by flooding from the Irrawaddy.

This development proposal is to extend levees on both sides of the horse-shoe easterly to high ground, and install pumps for irrigation and drainage as required. It is estimated that all the water for irrigation will need to be pumped from the river because of the high rim around the area. It is difficult to estimate the drainage requirements at this time, but for preliminary design the amount of drainage pumping has been assumed as the water remaining after evaporation, transpiration and percolation, and gravity flow. This amount is estimated at approximately 30% of the rainfall.

By installing the irrigation pumps to lift water either from the river or from the island drainage canal, extra capacity added to the irrigation installation will also handle all the drainage. General plan is shown on Plate 5.

(e) **Henzada-Zalun pump irrigation development.** This development is also another unit of the Delta pump irrigation development. It proposes irrigation in the Zalun and Henzada vicinity with water pumped from the Irrawaddy River above Henzada and Zalun. The pump locations being above tide water assures a water supply free of salt. These installations will provide the entire pumping requirements, supplying a canal constructed from the pump sites down through the entire area. The connection and cleaning of incomplete existing chaung courses will form the supply canals for dry season irrigation as well as provide drainage in the wet season. Excavation costs would be reduced to a minimum.

Only the area lying west of the Irrawaddy River and south from Henzada to the highway linking Danubyu and Thaunggyi has been considered for the development because of its topographical suitability to an improvement of this kind. A general plan is shown on Plate 5.

(f) Prome Area irrigation development. This project is in a very early study stage but its apparent physical possibilities as regards natural water resources available and agricultural lands topographically suited to irrigation make it worthy of inclusion in an over-all program for Burma. From cursory study of available maps, water supply may be from the Nawin Chaung, a river with a drainage area of over 500 square miles, and the Shwele Chaung with a drainage area of 200 square miles, or by pumping from the Irrawaddy River near Prome. The annual rainfall is not always sufficient for present crops but with an irrigation supply a second crop could be raised in the dry season as well as furnishing supplemental water for crops in the rainy season.

The one objectionable feature known about the area is the heavy silt surcharge of the rivers draining the Pegu Yomas from which the Nawin and Shwele Chaungs flow. Continued studies will determine the economic benefits from developing the area and the details of the proposed works. A general plan is shown on Plate 9.

(g) Mon River irrigation project. Detailed map studies of the area listed in the Preliminary Report to be irrigated under the Mon River multi-purpose project have disclosed only a part of the acreage geographically suited for services from the Mon River. Most of this acreage is presently irrigated by systems receiving river-run supply by diversion from three sources. These systems—the Mon River, the Man River and the Salin River—were discussed in Paragraph A–2–b of this chapter.

A weir at Mezali diverts water from the Mon River into a system of canals on both sides of the river for service to 119,800 gross acres. A weir on the Salin River, north of the Mon, diverts water for service to 29,700 gross acres. A weir on the Man River, south of the Mon, diverts water for service to 28,630 gross acres. Of this 178,130 gross acres, 122,090 acres are irrigated annually. The loss in acreage is due to unequal distribution of periods of water supply, inadequacies in the distribution system, and flooding by the Irrawaddy River of land adjacent thereto.

Additional benefits would accrue to the area by the construction of a storage reservoir dam under the hydroelectric development, making possible the storing of water now wasted. The storage would be available for irrigation use on second cropping during the dry season and cropping on areas flooded in the wet season, for stabilization of the supply for supplemental water in the rainy season, and for expansion of irrigation to areas not now served. The three projects should be connected into a single system, however, to benefit all three areas and economically use the available water supply. This would require costly revising and rebuilding of portions of the existing works because the existing Mon River diversion is lower in elevation than either of the other two.

In addition, a storage reservoir on the Mon River of capacity for sufficient annual runoff to supply the acreage to be benefited by irrigation and for operation of the proposed hydroelectric installation, will inundate many acres now cultivated and numerous small villages. The entire development area is also in the hands of insurgents. It has seemed advisable to defer further study on this development to a later priority. Developments in other areas more in need will have been completed, and refinements in present installations will then be open for consideration. Location of the existing works and the area served is shown on Plate 3. Improvements to existing works would improve operation efficiency, but these must wait for settled conditions to return to the area.

(h) Yanbe and Yin Rivers. Irrigation from these rivers was listed in the Preliminary Report. A cursory study of maps available in the area of Taungdwingyi shows the area to be rather rough, and the rivers heavily silt-laden. Detailed field data would be needed for analysis of the area for irrigation. It has been concluded that these projects should be deferred until future needs require expansion of irrigation to less feasible areas in present economic conditions.

(i) Myitnge, Myittha, Shweli and Irrawaddy Rivers. Developments on these rivers were listed as possibilities in the Preliminary Report. Further study has shown little need for storage reservoirs on these rivers for irrigation. Each source yields an abundance of water but the demand will be far in the future, and the investment required excessive for present needs. No further study is recommended for the present.

b. Assumptions and Criteria for Planning

Except in cases where design is based on actual known data, assumptions and criteria for the particular conditions are established from similar situations on which information is available.

(1) Consumptive Use of Water

Consumptive use of water is the quantity of water in acre feet of cropped acre per year absorbed by the crop and transpired or used directly in the building of plant tissue, together with evaporation from the soil. The initial criterion to be established in the design of an irrigation development is this consumptive use. The amount of water supplied from the irrigation system is the difference between the consumptive use by the crop per season and the natural rainfall moisture in the soil for the plant use.

Consumptive use of water can be accurately determined if the soil has been classified and the crop to be grown on each type of soil is known. This procedure has been carried out to some degree throughout the Yamethin District project area and explained in detail in the discussion under Section B of this chapter. Consumptive use requirements thus established are necessary in the detailed design of a project and distribution allocations if the supply is short.

The preliminary designs in this Report have been based on consumptive use data provided from records of water used in irrigated areas, and rainfall utilization in non-irrigated areas determined from the difference between annual inflow and outflow. Detailed studies of these records, and the area conditions on which they were kept, established a definite relationship between consumptive use of water and temperature. Moisture and plant food are required in proportion to the heat utilized. The curve on Plate 10 for consumptive use of water based on effective heat, or the accumulation in day-degrees of maximum daily temperatures above germinating temperature, taken as 32°F. during the growing season, was prepared from this knowledge and data. Maximum daily temperatures during the growing season, length of growing season, rainfall, and inflow and outflow from the area must be known in addition to using the curve to determine consumptive use of water for a locality.

Sufficient data, together with assumptions based on knowledge of local conditions in Burma, have made it possible to establish a reasonable value for annual water requirements for irrigation planning. Consumptive use has been established by plotting day-degrees on the curve; the value thus indicated less the average annual rainfall, less runoff, being the water service per acre.

Experience and observation have shown that there is very little plant growth in the unirrigated areas during the dry season in Burma. Practically all of the annual precipitation may be assumed as being used up during the rainy season and early part of the dry season by runoff, evaporation, and transpiration. Therefore, water service requirements have been determined for each crop period as a complete cycle in itself rather than for the year as a whole.

The irrigation demand used in the general planning of the projects is as follows:

(a) Mu River irrigation project, Yamethin District irrigation project and Loikaw Area irrigation project. Based on consumptive use of water determined as described heretofore.

Dry season crop, canal evaporation included: 36 inches.

Rainy season crop, canal evaporation included: 12 inches.

Canal seepage losses are assumed as remaining in the area.

Well Irrigation:

Both crop seasons: 36 inches total (on the assumption that crops requiring less water would be cultivated under well irrigation).

Maximum water requirement any month: 12 inches (based on detailed studies made for Yamethin District irrigation project).

(b) All delta pump irrigation developments, including Pegu and Buthidaung areas. Based on assumption rather than method described heretofore, because of the lack of specific data.

Dry season crop irrigation only.

60 inches per season on 30% of the area (rice crop).

12 inches per season on 70% of the area (other crops).

(2) Data Used in Studies

Detailed field data and investigations necessary for design plans are not complete. Specific local data and surveys used in the planning are as follows:

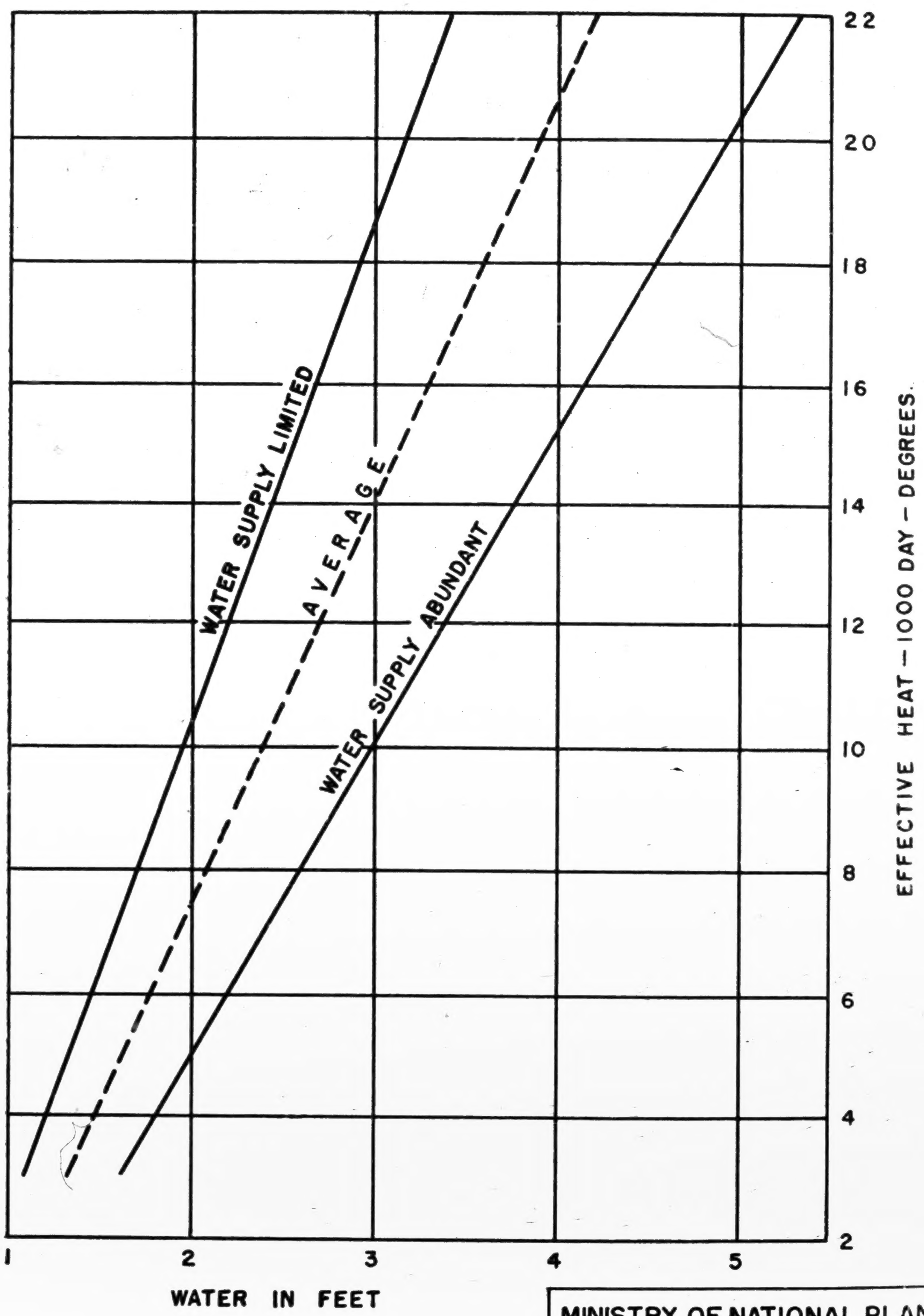
Settlement reports for data on economic conditions in an area, general soil information, rainfall, and crops raised.

One inch per mile scale maps by Air Surveys of India for drainage areas and topographic characteristics for canal location and dam locations, and determination of reservoir capacity and area to be irrigated.

Runoff factors for stream flow were obtained from existing reports, most of which are incomplete and serve only as a basis of assumptions.

Crops yields and soil classification from report "An Economic Classification of Land in Burma" by J. T. Sanders and U Ba Tin.

Report of reconnaissance survey of dam and reservoir sites on the Paunglaung River, Yezin and Thitson Chaungs by the Burma Geological Department. Geological data on the project areas from the same Department.

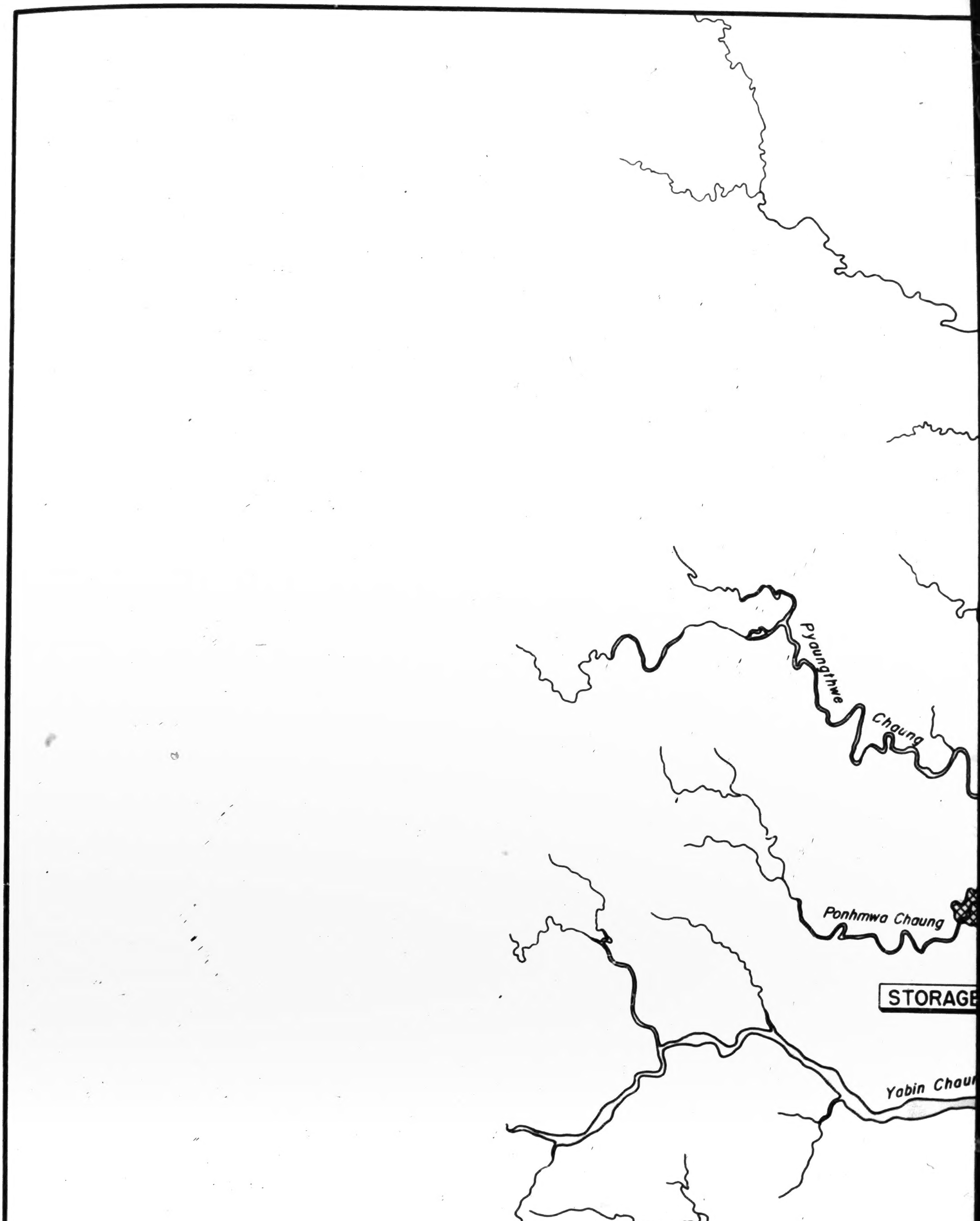


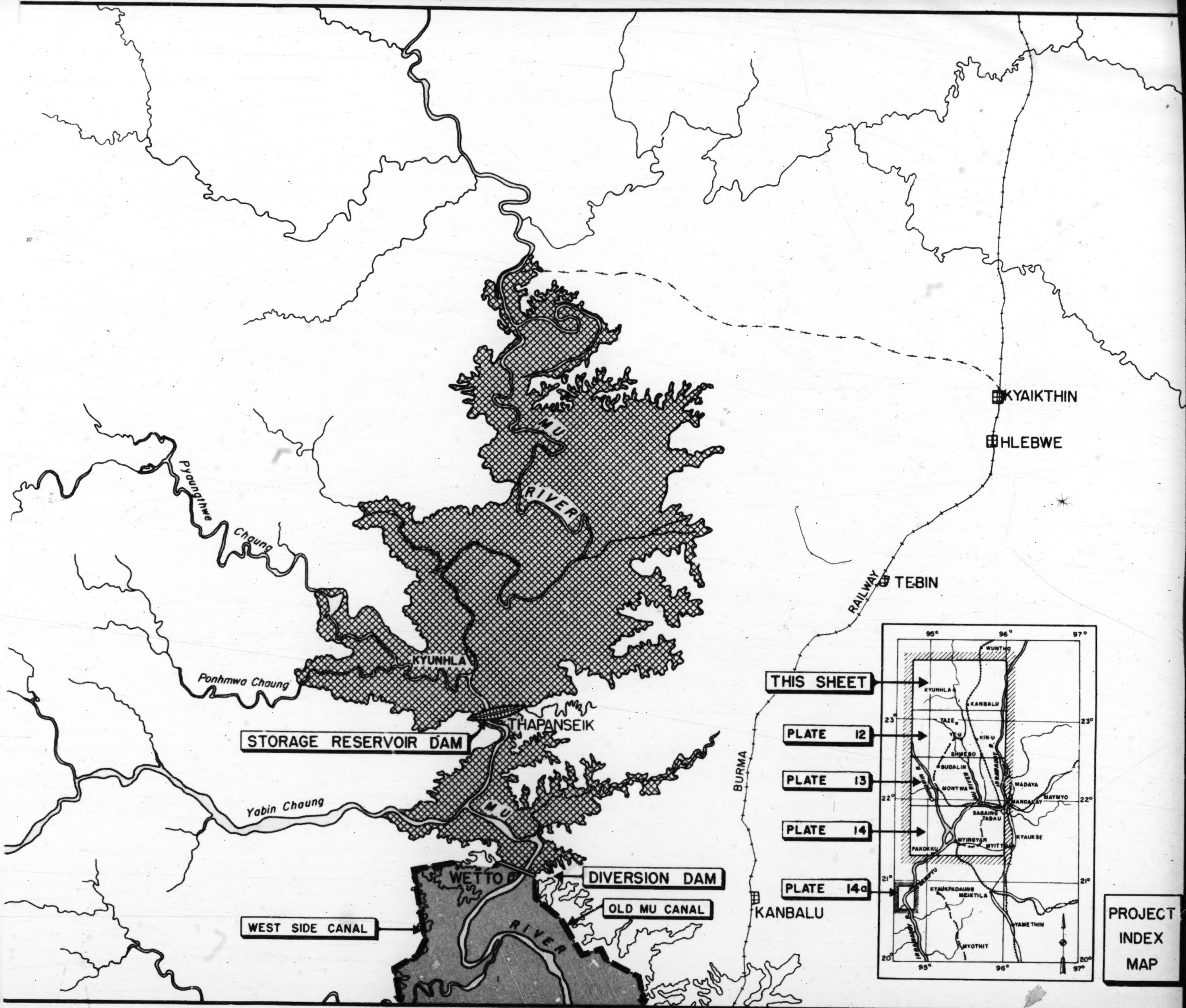
MINISTRY OF NATIONAL PLANNING

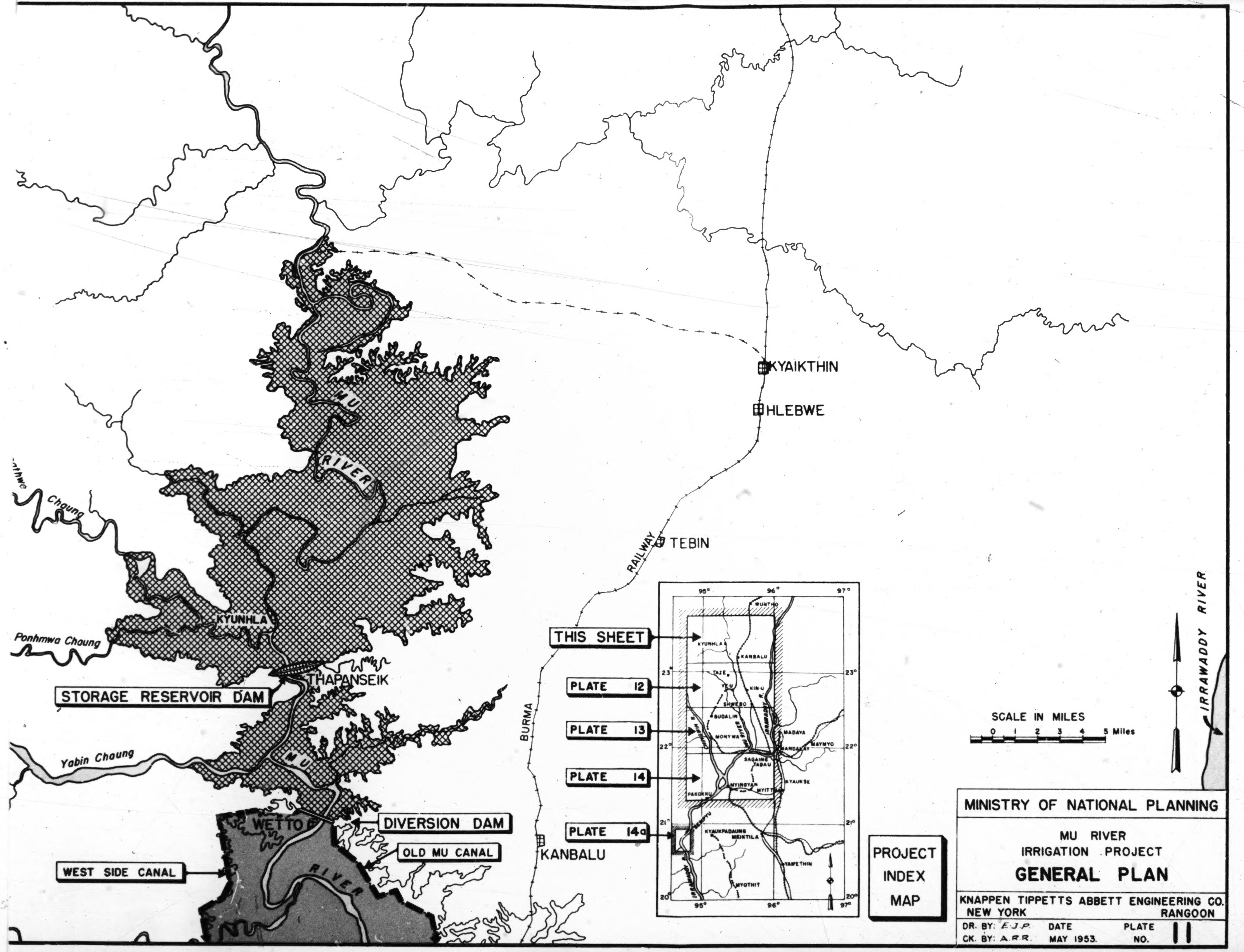
CONSUMPTIVE
USE OF WATER

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY: E.J.P. DATE PLATE
CK. BY: A.R.R. JULY 53. NO. **10**


Pyaungthwe Chaung
Ponhmwa Chaung
STORAGE
Yabin Chau
WEST SIDE


MU
RIVER
Pyaungthwe Chaung
KYAIKTHIN
HLEBWE
TEBIN
RAILWAY
BURMA
KYUNHLA
Ponhmwa Chaung
THAPANSEIK
STORAGE RESERVOIR DAM
Yabin Chaung
MU
WETTO
DIVERSION DAM
OLD MU CANAL
WEST SIDE CANAL
RIVER
KANBALU
THIS SHEET
PLATE 12
PLATE 13
PLATE 14
PLATE 14a
95°
96°
97°
23°
22°
21°
20°
WUNTHO
KYUNHLA
KANBALU
TAZE
YEU
KIN-U
SHWEBO
BUDALIN
MONYWA
MU RIVER
CHINDWIN R.
IRRAWADDY R.
MADAYA
MANDALAY
MAYMYO
SAGAING
TADAU
MYINGYAN
MYITTHA
KYAUKSE
PAKOKKU
SEIKPYU
KYAUKPADAUNG
MEIKTILA
YAMETHIN
MYOTHIT
IRRAWADDY
PROJECT INDEX MAP


KYAIKTHIN
HLEBWE
TEBIN
RAILWAY
BURMA
KANBALU
MU
RIVER
MU
RIVER
Chaung
Ponhmwa Chaung
Yabin Chaung
KYUNHLA
THAPANSEIK
STORAGE RESERVOIR DAM
WETTO
DIVERSION DAM
OLD MU CANAL
WEST SIDE CANAL
THIS SHEET
PLATE 12
PLATE 13
PLATE 14
PLATE 14a
95°
96°
97°
23°
22°
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20°
WUNTHO
KYUNHLA
KANBALU
TAZE
YEU
KIN-U
SHWEBO
BUDALIN
MONYWA
MADAYA
MANDALAY
MAYMYO
SAGAING
TADAU
PAKOKKU
MYINGYAN
MYITTHA
KYAUKSE
KYAUKPADAUNG
MEIKTILA
YAMETHIN
MYOTHIT
PROJECT INDEX MAP
IRRAWADDY RIVER
SCALE IN MILES
0 1 2 3 4 5 Miles

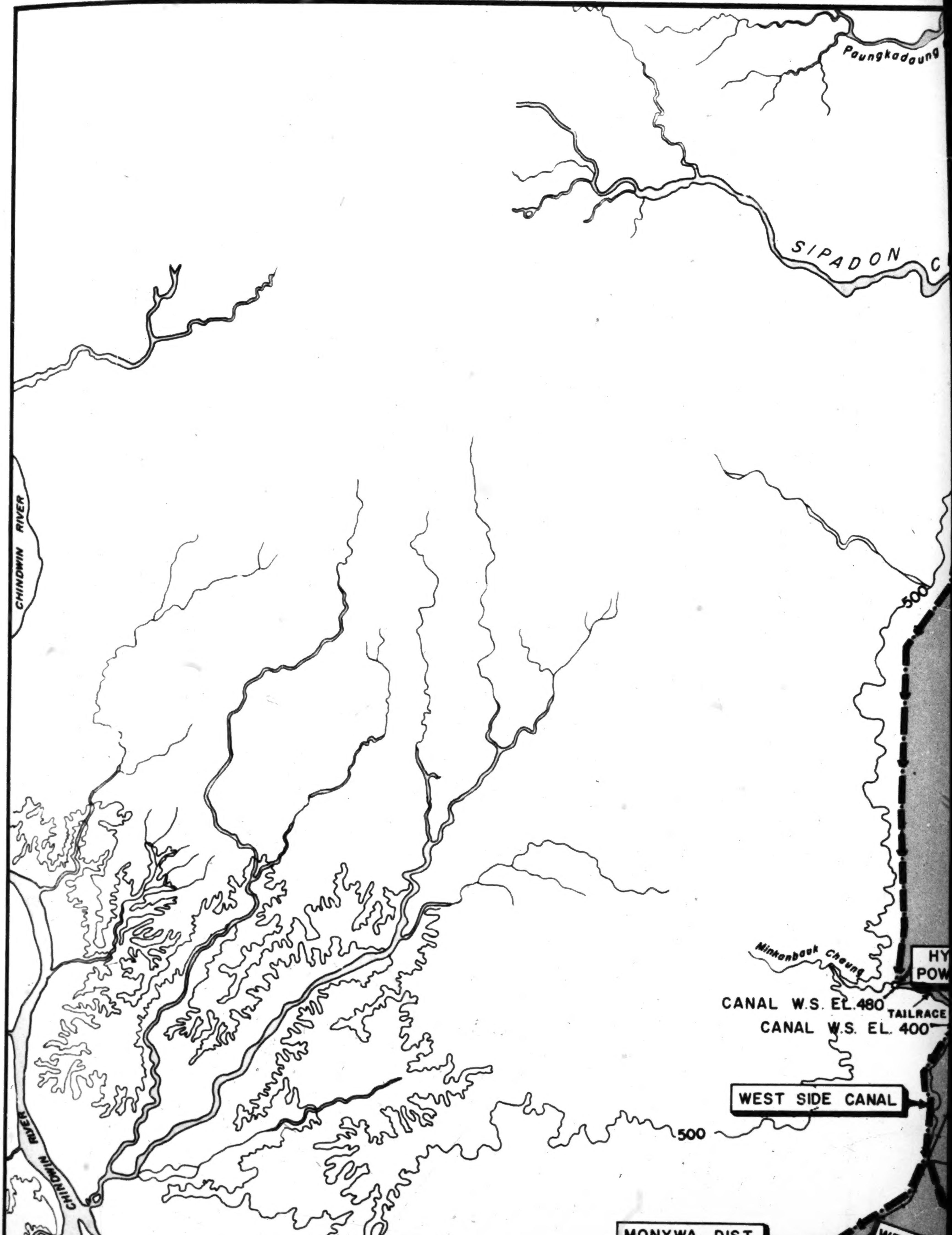
MINISTRY OF NATIONAL PLANNING

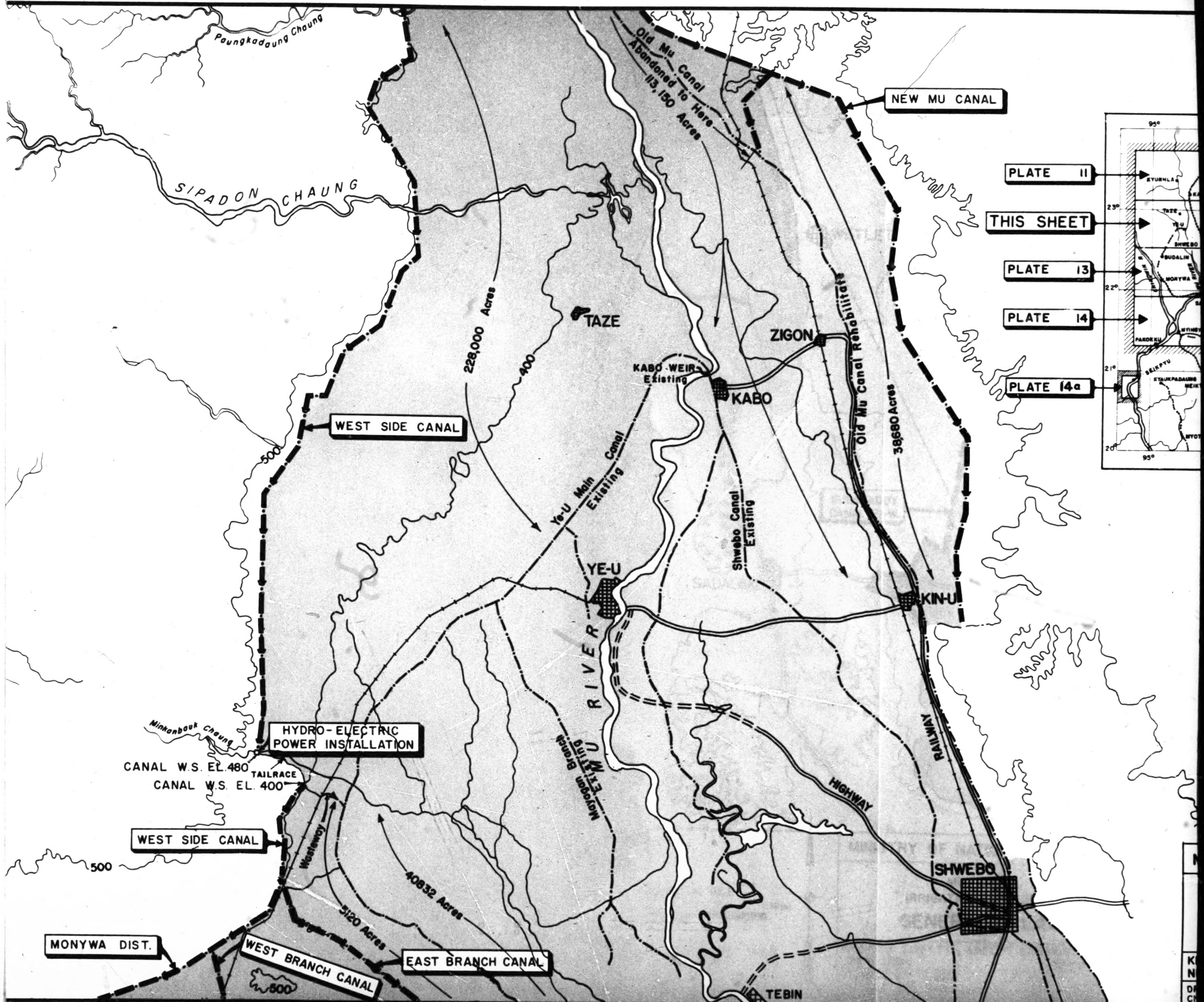
MU RIVER
IRRIGATION PROJECT

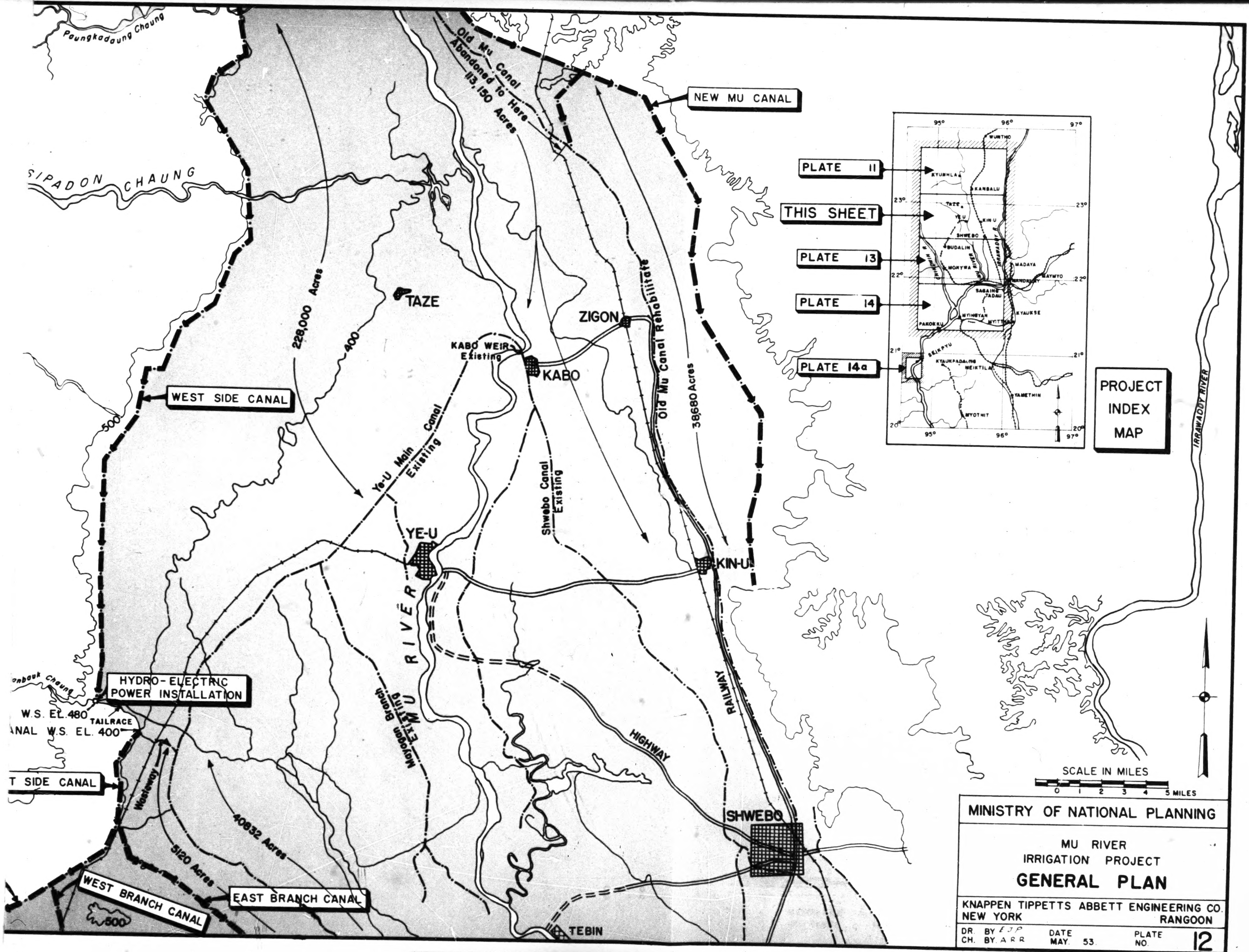
GENERAL PLAN

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY: E.J.P. DATE PLATE
CK. BY: A.R.R. MAY 1953. NO. 11


Paungkadaung
SIPADON C
CHINDWIN RIVER
500
Minkonbauk Chaung
HY
POW
CANAL W.S. EL.480
TAILRACE
CANAL W.S. EL. 400
WEST SIDE CANAL
500
CHINDWIN RIVER
MONYWA DIST.
WEST BR
500


Paungkadaung Chaung
SIPADON CHAUNG
Old Mu Canal Abandoned to Here 113,150 Acres
NEW MU CANAL
228,000 Acres
400
TAZE
ZIGON
KABO-WEIR Existing
KABO
WEST SIDE CANAL
500
Ye-U Main Canal Existing
Old Mu Canal Rehabilitate
38680 Acres
Shwebo Canal Existing
YE-U
KIN-U
MU RIVER
Mayagan Branch Existing
RAILWAY
HIGHWAY
Minkanbauk Chaung
HYDRO-ELECTRIC POWER INSTALLATION
CANAL W.S. EL. 480
TAILRACE
CANAL W.S. EL. 400
WEST SIDE CANAL
Wasteway
40832 Acres
5120 Acres
500
MONYWA DIST.
WEST BRANCH CANAL
EAST BRANCH CANAL
SHWEBO
TEBIN
MINISTRY OF NA
SEN
PLATE 11
THIS SHEET
PLATE 13
PLATE 14
PLATE 14a
95°
23°
22°
21°
20°
KYUNHLA
TAZE
YE-U
SHWEBO
BUDALIN
MONYWA
CHINDWIN R.
MU RIVER
PAKOKKU
MYINGY
SEIKPYU
KYAUKPADAUNG
MEIKT
MYOT


Paungkadaung Chaung
SIPADON CHAUNG
Old Mu Canal Abandoned to Here 113,150 Acres
NEW MU CANAL
228,000 Acres
400
TAZE
KABO WEIR Existing
KABO
ZIGON
Old Mu Canal Rehabilitate
38,680 Acres
WEST SIDE CANAL
500
Ye-U Main Canal Existing
Shwebo Canal Existing
YE-U
KIN-U
MU RIVER
HYDRO-ELECTRIC POWER INSTALLATION
W.S. EL. 480
TAILRACE
ANAL W.S. EL. 400
T SIDE CANAL
Wasteway
Mayagan Branch Existing
40832 Acres
5120 Acres
WEST BRANCH CANAL
EAST BRANCH CANAL
500
HIGHWAY
RAILWAY
SHWEBO
TEBIN
IRRAWADDY RIVER
PLATE 11
THIS SHEET
PLATE 13
PLATE 14
PLATE 14a
95°
96°
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22°
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20°
WUNTHO
KYUNHLA
KANBALU
TAZE
YE-U
KIN-U
SHWEBO
BUDALIN
MONYWA
MADAYA
MANDALAY
MAYMYO
SAGAING
TADAU
PAKOKKU
MYINGYAN
MYITTHA
KYAUKSE
SEIKPYU
KYAUKPADAUNG
MEIKTILA
YAMETHIN
MYOTHIT
PROJECT INDEX MAP
SCALE IN MILES
0 1 2 3 4 5 MILES

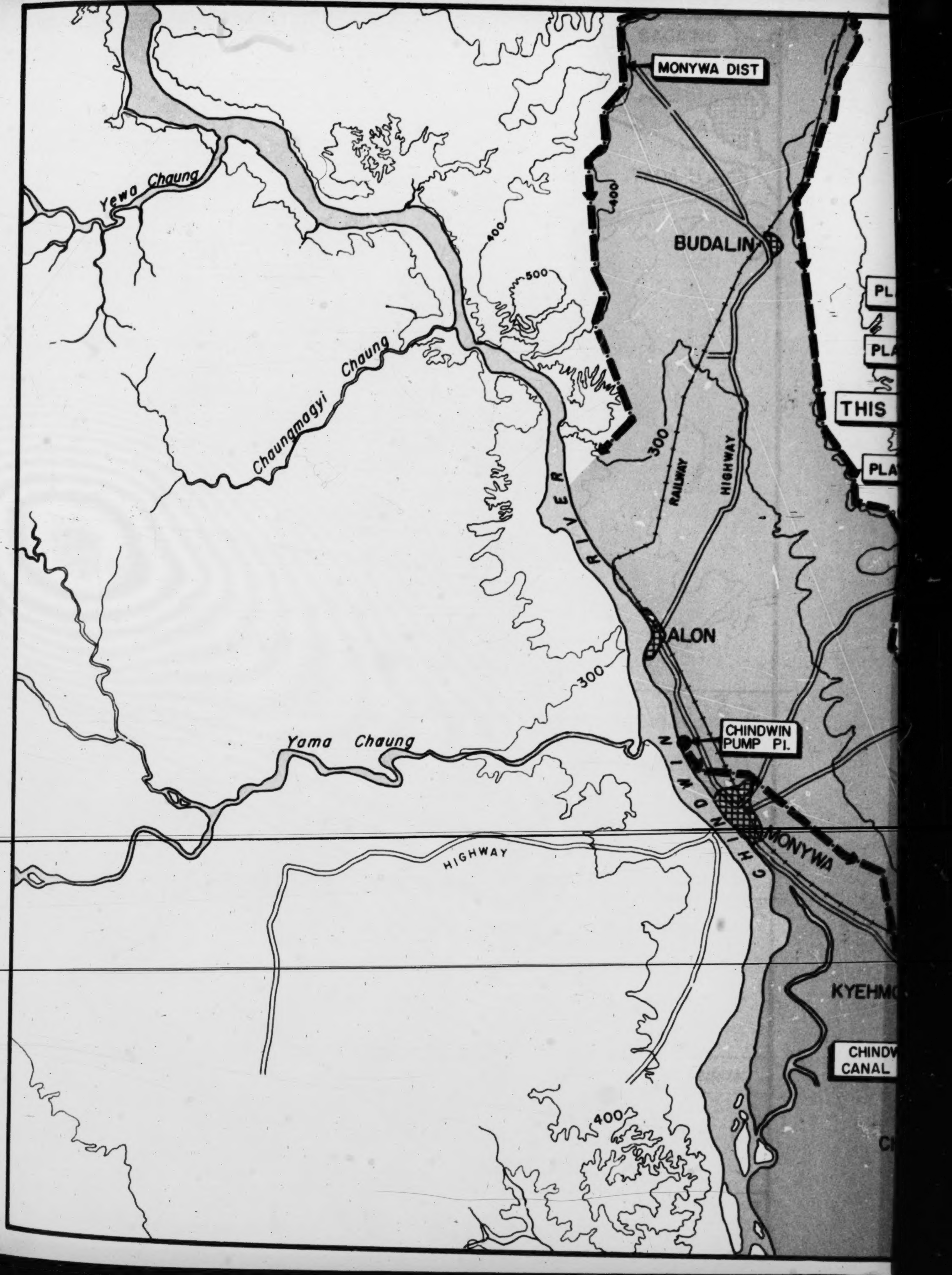
MINISTRY OF NATIONAL PLANNING

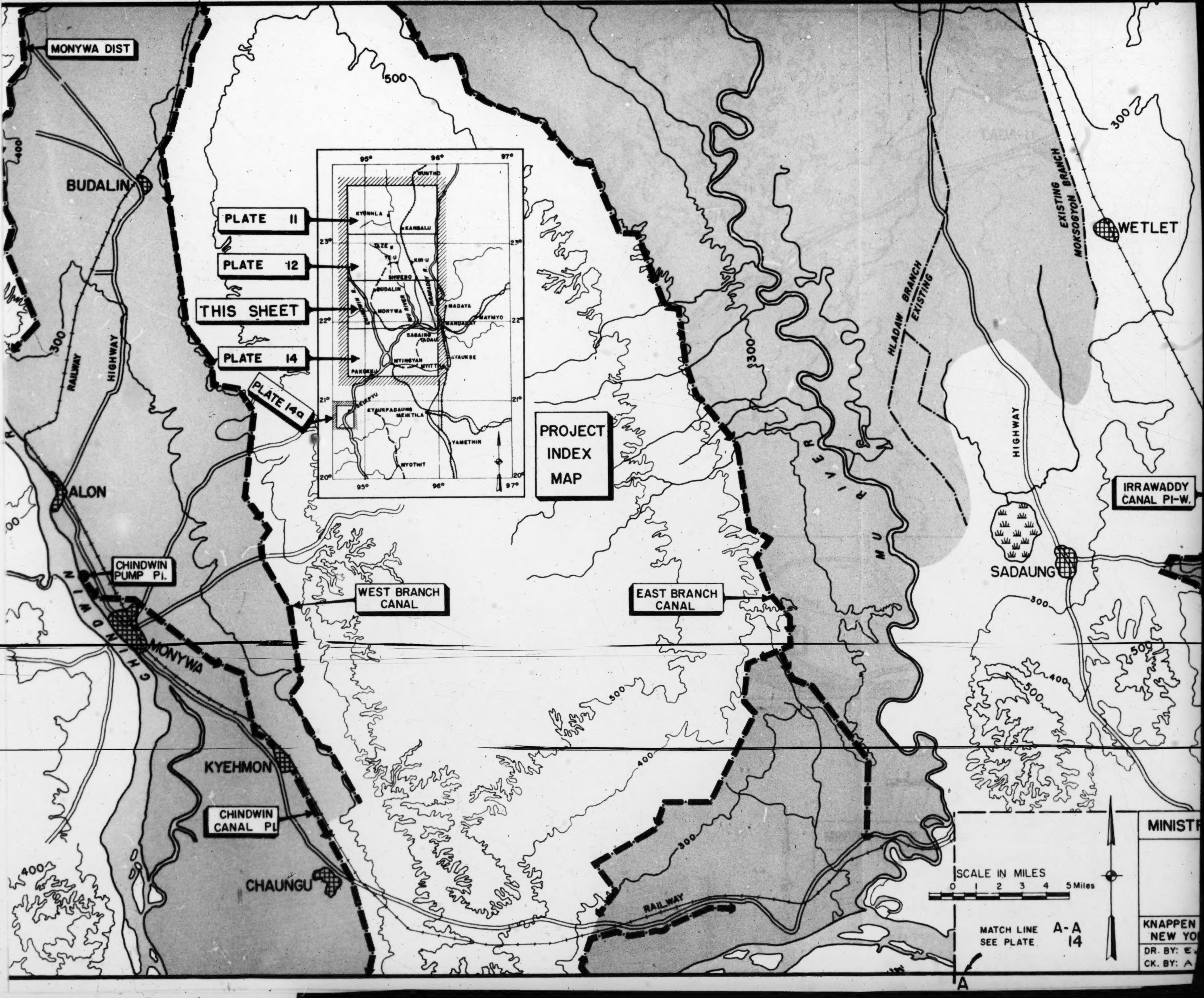
MU RIVER
IRRIGATION PROJECT

GENERAL PLAN

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P.
CH. BY A.R.R.
DATE MAY. 53.
PLATE NO. 12


MONYWA DIST
Yewa Chaung
400
BUDALIN
500
PLA
PLA
THIS
Chaungmagyi Chaung
300
RAILWAY
HIGHWAY
PLA
RIVER
ALON
300
CHINDWIN PUMP Pl.
Yama Chaung
CHINDWIN
MONYWA
HIGHWAY
KYEHMO
CHINDW CANAL
400
CH


MONYWA DIST
BUDALIN
ALON
300
400
RAILWAY
HIGHWAY
CHINDWIN PUMP Pl.
CHINDWIN
MONYWA
KYEHMON
CHINDWIN CANAL Pl.
CHAUNGU
400
500
PLATE 11
PLATE 12
THIS SHEET
PLATE 14
PLATE 14a
95°
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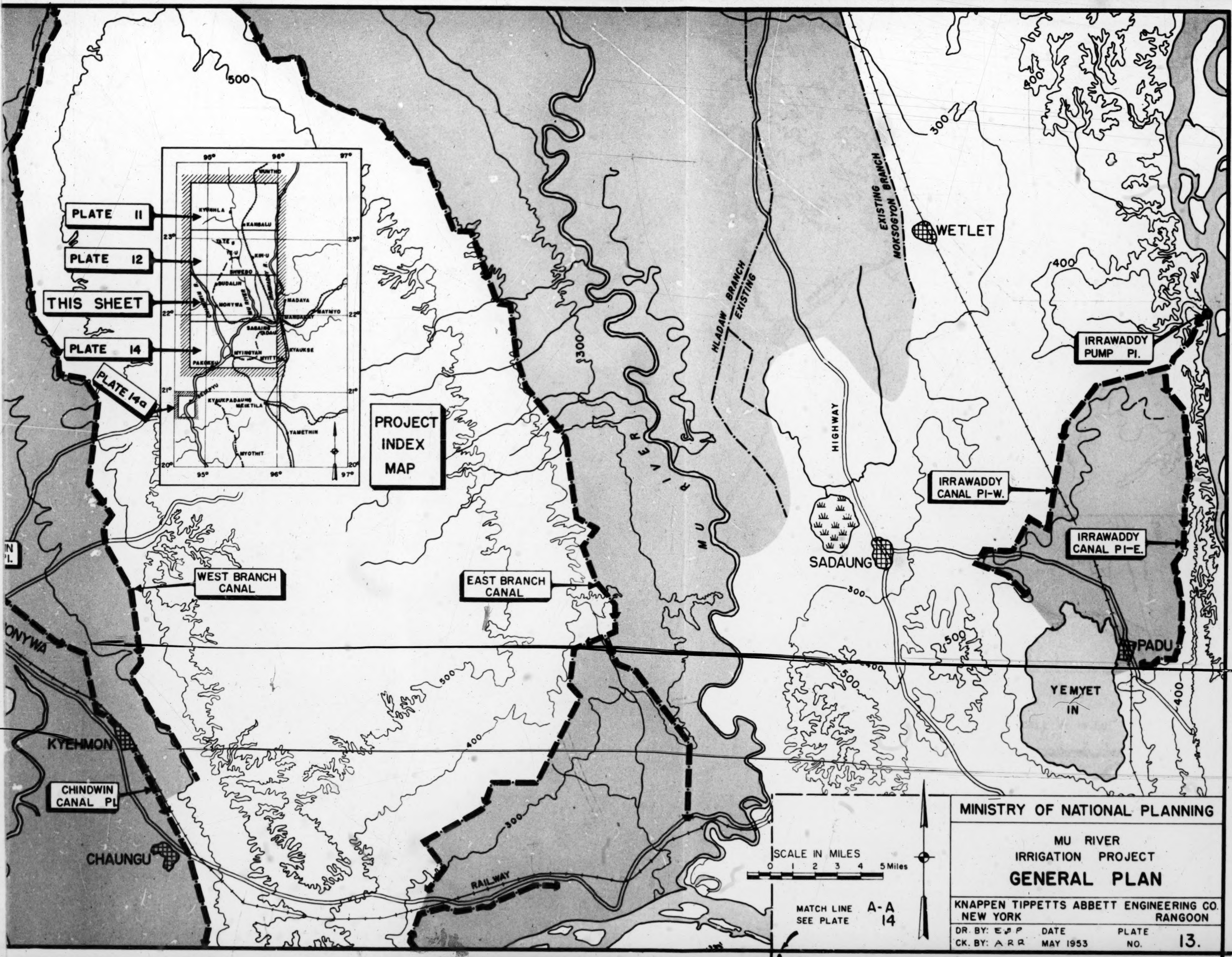
97°
23°
22°
21°
20°
WUNTHO
KYUNHLA
KANBALU
TAZE
YE-U
KIN-U
SHWEBO
BUDALIN
MONYWA
CHINDWIN R.
MU RIVER
IRRAWADDY R.
MADAYA
MANDALAY
MAYMYO
SAGAING
TADAU
KYAUKSE
MYINGYAN
MYITTHA
PAKOKKU
SEIKPYU
KYAUKPADAUNG
MEIKTILA
YAMETHIN
MYOTHIT
PROJECT INDEX MAP
WEST BRANCH CANAL
EAST BRANCH CANAL
500
400
300
MU RIVER
HLADAW BRANCH EXISTING
EXISTING MOKSOGYON BRANCH
WETLET
HIGHWAY
IRRAWADDY CANAL Pl-W.
SADAUNG
300
400
500
RAILWAY
SCALE IN MILES
0 1 2 3 4 5 Miles
MATCH LINE A-A
SEE PLATE 14
A
MINISTR
KNAPPEN
NEW YO
DR. BY: E.
CK. BY: A


500
PLATE 11
PLATE 12
THIS SHEET
PLATE 14
PLATE 14a
95°
96°
97°
WUNTHO
KYUNHLA
KANBALU
23°
TAZE
YE-U
KIN-U
SHWEBO
BUDALIN
MONYWA
MU RIVER
IRRAWADDY R.
CHINDWIN R.
MADAYA
MAYMYO
22°
MANDALAY
SAGAING
TADAU
KYAUKSE
MYINGYAN
MYITTHA
PAKOKKU
21°
SEIKPYU
KYAUKPADAUNG
MEIKTILA
YAMETHIN
MYOTHIT
20°
PROJECT INDEX MAP
300
WEST BRANCH CANAL
EAST BRANCH CANAL
MU RIVER
HLADAW BRANCH EXISTING
EXISTING MOKSOGYON BRANCH
WETLET
HIGHWAY
SADAUNG
400
IRRAWADDY PUMP PI.
IRRAWADDY CANAL PI-W.
IRRAWADDY CANAL PI-E.
PADU
YEMYET IN
IN PI.
ONYWA
KYEHMON
CHINDWIN CANAL PI.
CHAUNGU
RAILWAY
SCALE IN MILES
0 1 2 3 4 5 Miles
MATCH LINE A-A
SEE PLATE 14
A

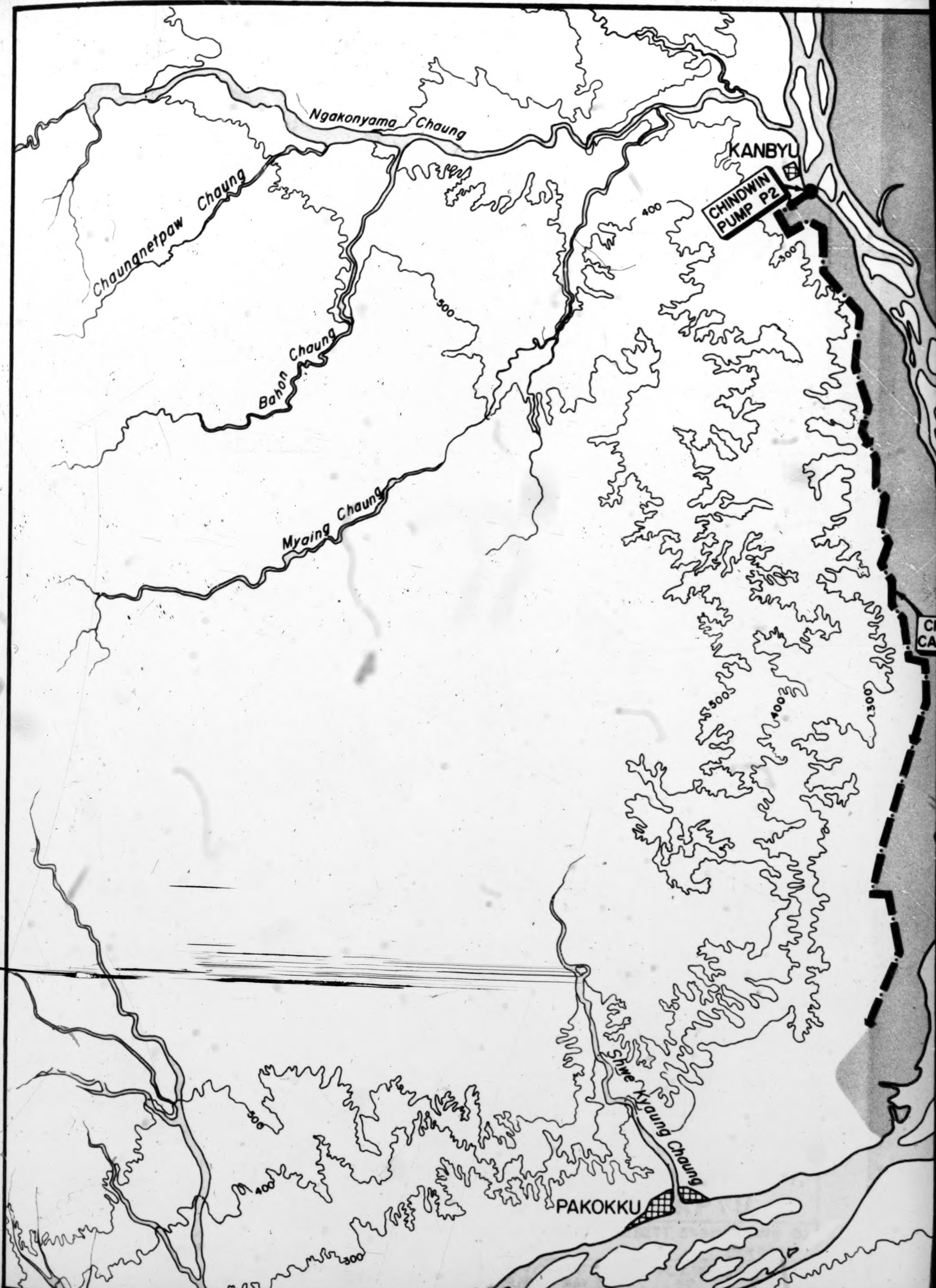
MINISTRY OF NATIONAL PLANNING

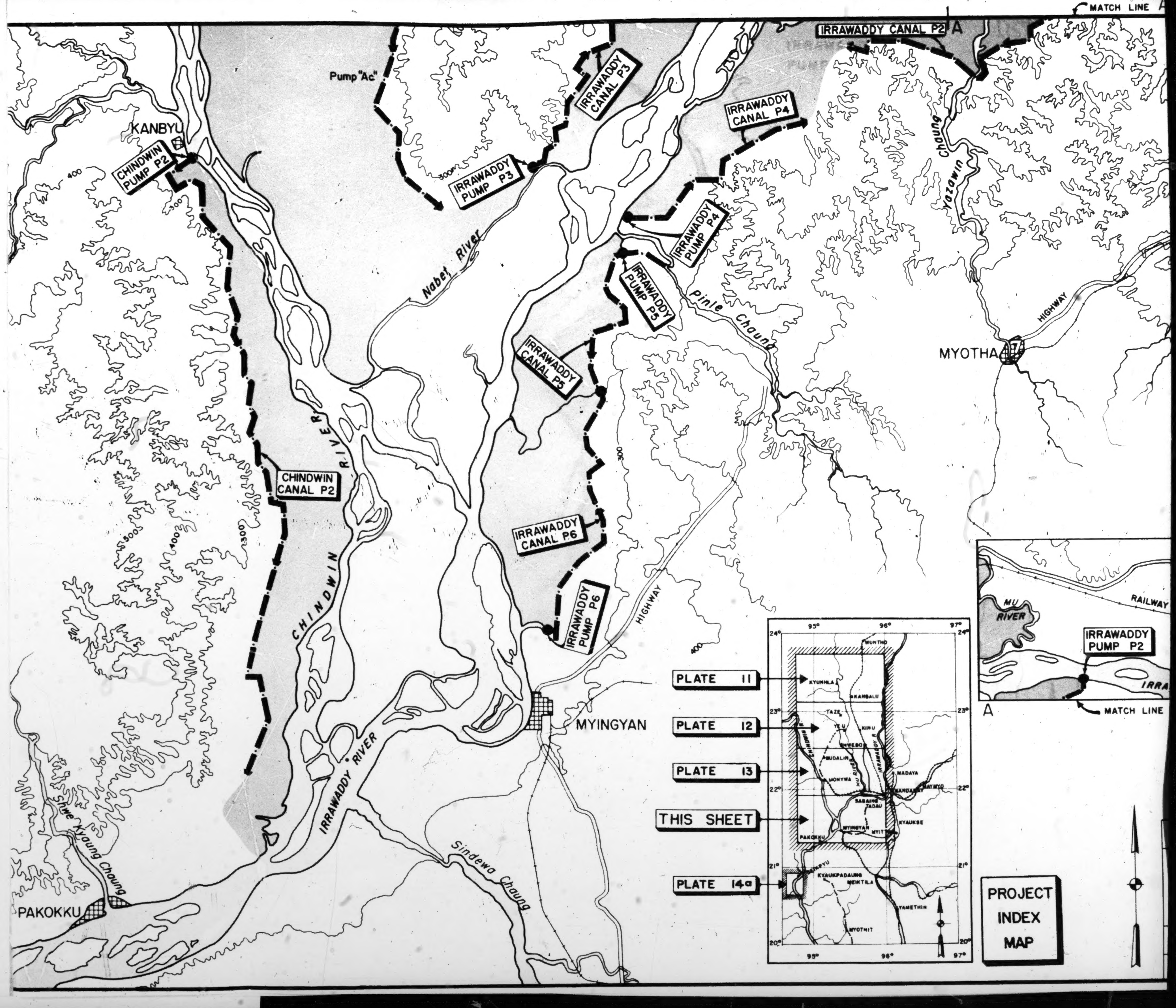
MU RIVER
IRRIGATION PROJECT

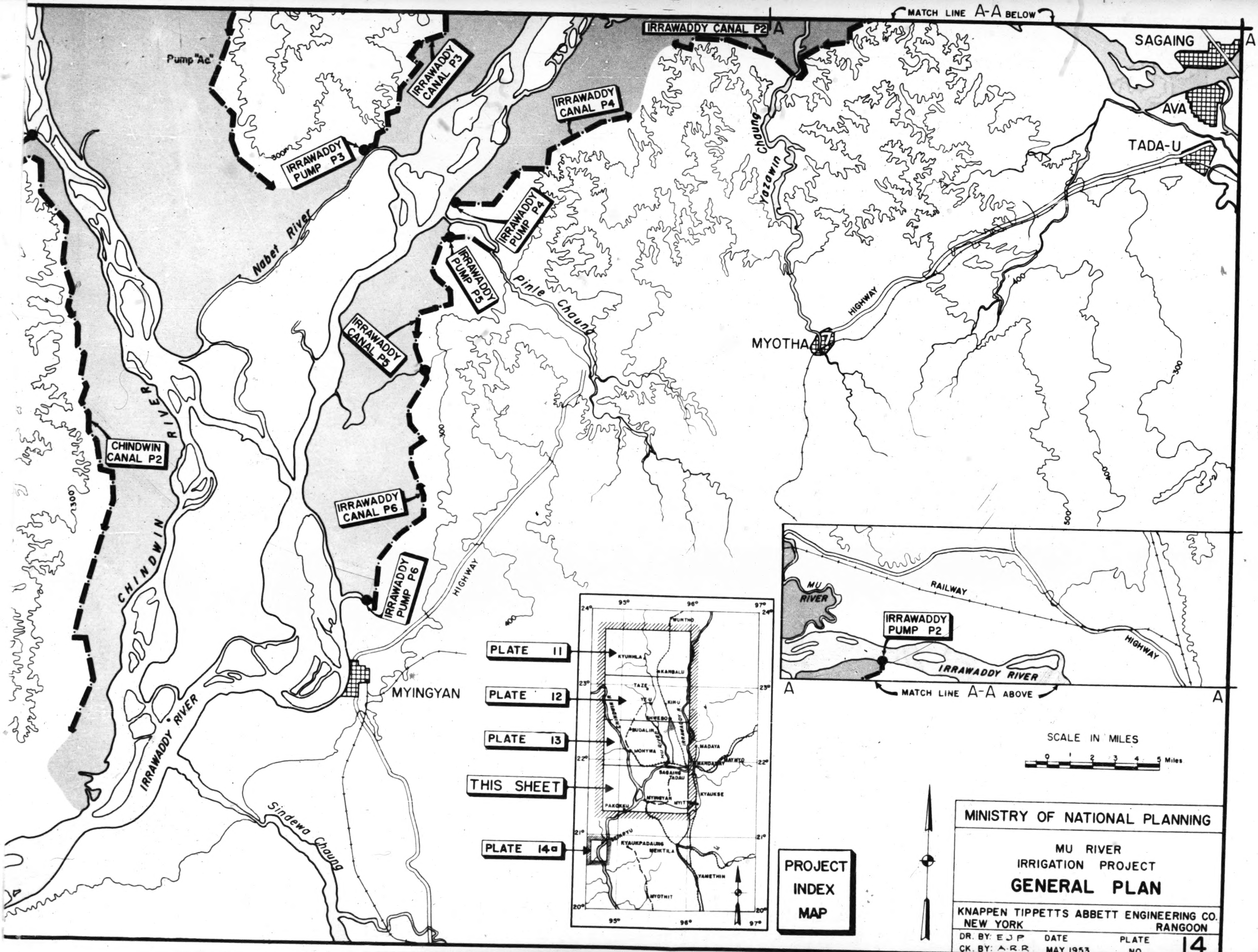
GENERAL PLAN

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY: E.J.P.	DATE	PLATE	
CK. BY: A.R.R.	MAY 1953	NO.	13.


Ngakonyama Chaung
KANBYU
CHINDWIN PUMP P2
Chaungnetpaw Chaung
400
300
500
Bahon Chaung
Myaing Chaung
CH
CA
500
400
300
Shwe Kyaung Chaung
500
400
PAKOKKU
300


MATCH LINE A
IRRAWADDY CANAL P2
A
Pump "Ac"
IRRAWADDY CANAL P3
IRRAWADDY CANAL P4
KANBYU
CHINDWIN PUMP P2
400
300
IRRAWADDY PUMP P3
IRRAWADDY PUMP P4
Yazawin Chaung
Nabet River
IRRAWADDY PUMP P5
Pinle Chaung
HIGHWAY
MYOTHA
IRRAWADDY CANAL P5
CHINDWIN RIVER
CHINDWIN CANAL P2
IRRAWADDY CANAL P6
500
IRRAWADDY PUMP P6
HIGHWAY
400
MU RIVER
RAILWAY
IRRAWADDY PUMP P2
IRRA
A
MATCH LINE
MYINGYAN
IRRAWADDY RIVER
Sindewa Chaung
Shwe Kyaung Chaung
PAKOKKU
PLATE 11
PLATE 12
PLATE 13
THIS SHEET
PLATE 14a
95°
96°
97°
24°
23°
22°
21°
20°
WUNTHO
KYUNHLA
KANBALU
TAZE
YE-U
KIN-U
SHWEBO
BUDALIN
CHINDWIN R.
MU RIVER
IRRAWADDY R.
MONYWA
MADAYA
MAYMYO
MANDALAY
SAGAING
TADAU
KYAUKSE
MYINGYAN
MYITTHA
PAKOKKU
SEIKPYU
KYAUKPADAUNG
MEIKTILA
YAMETHIN
MYOTHIT
PROJECT INDEX MAP

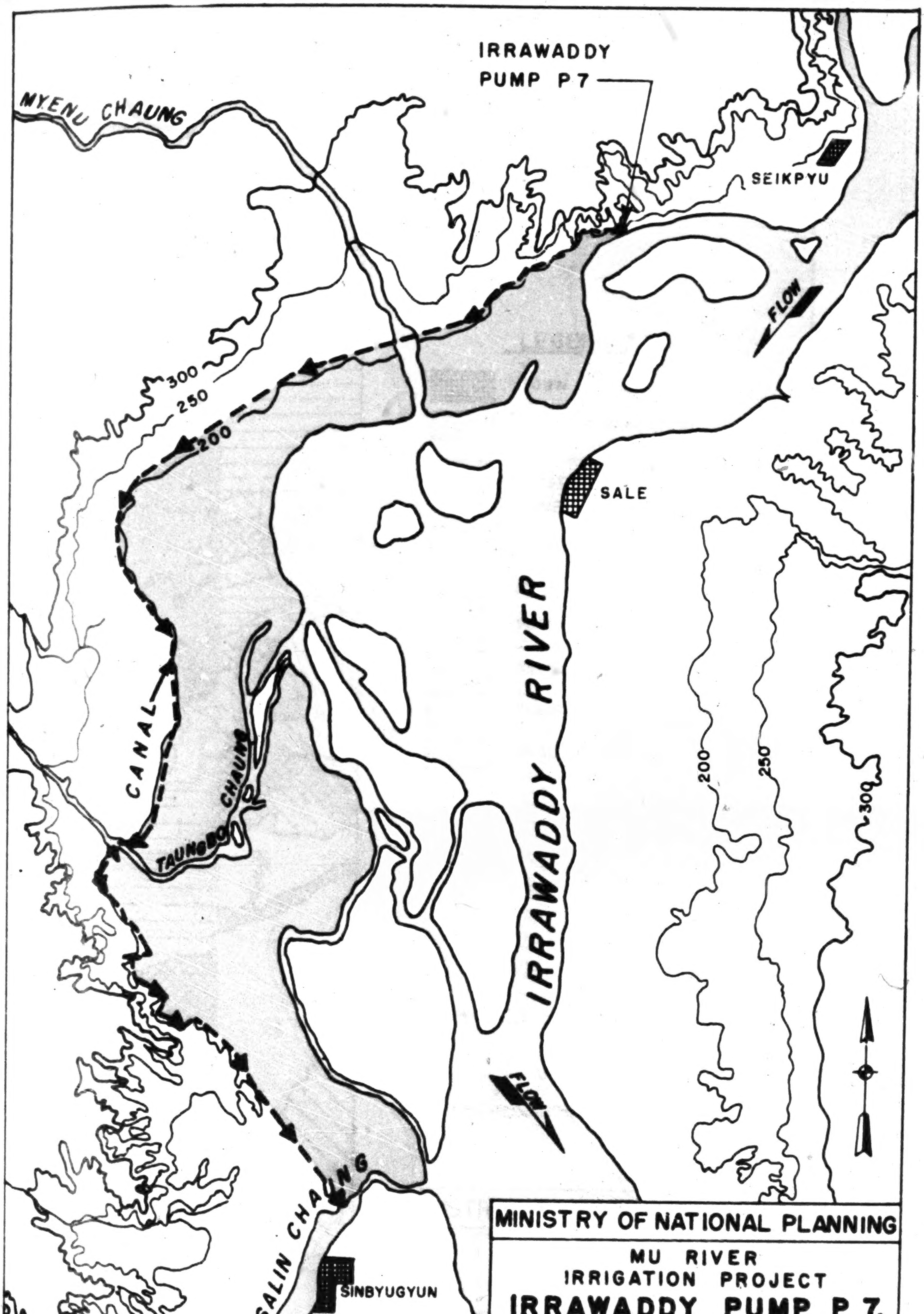

MATCH LINE A-A BELOW
IRRAWADDY CANAL P2
SAGAING
AVA
TADA-U
Pump "Ac"
IRRAWADDY CANAL P3
IRRAWADDY CANAL P4
IRRAWADDY PUMP P3
IRRAWADDY PUMP P4
IRRAWADDY PUMP P5
IRRAWADDY CANAL P5
IRRAWADDY CANAL P6
IRRAWADDY PUMP P6
CHINDWIN CANAL P2
CHINDWIN RIVER
IRRAWADDY RIVER
Nabet River
Pinle Chaung
Yazawin Chaung
Sindewa Chaung
HIGHWAY
MYOTHA
MYINGYAN
300
400
500
PLATE 11
PLATE 12
PLATE 13
THIS SHEET
PLATE 14a
PROJECT INDEX MAP
MU RIVER
RAILWAY
IRRAWADDY PUMP P2
IRRAWADDY RIVER
MATCH LINE A-A ABOVE
A
SCALE IN MILES
0 1 2 3 4 5 Miles

MINISTRY OF NATIONAL PLANNING

MU RIVER
IRRIGATION PROJECT
GENERAL PLAN

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY: E.J.P. DATE MAY 1953 PLATE NO. 14
CK. BY: A.R.R.


IRRAWADDY
PUMP P7
MYENU CHAUNG
SEIKPYU
FLOW
300
250
200
SALE
IRRAWADDY RIVER
CANAL
TAUNGBO CHAUNG
200
250
300
FLOW
SALIN CHAUNG
SINBYUGYUN
SCALE IN MILES
1 1/2 0 1 2

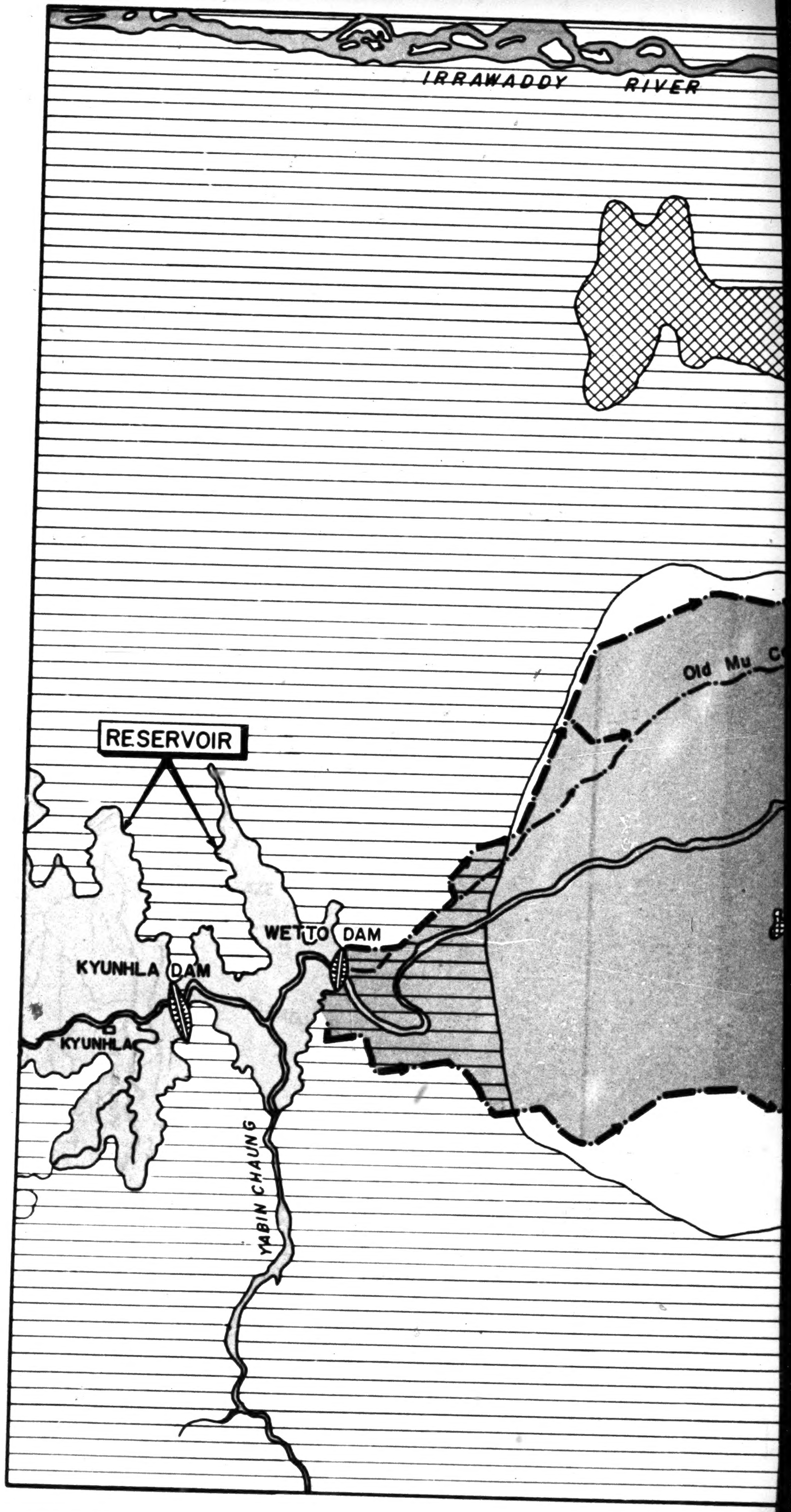
MINISTRY OF NATIONAL PLANNING

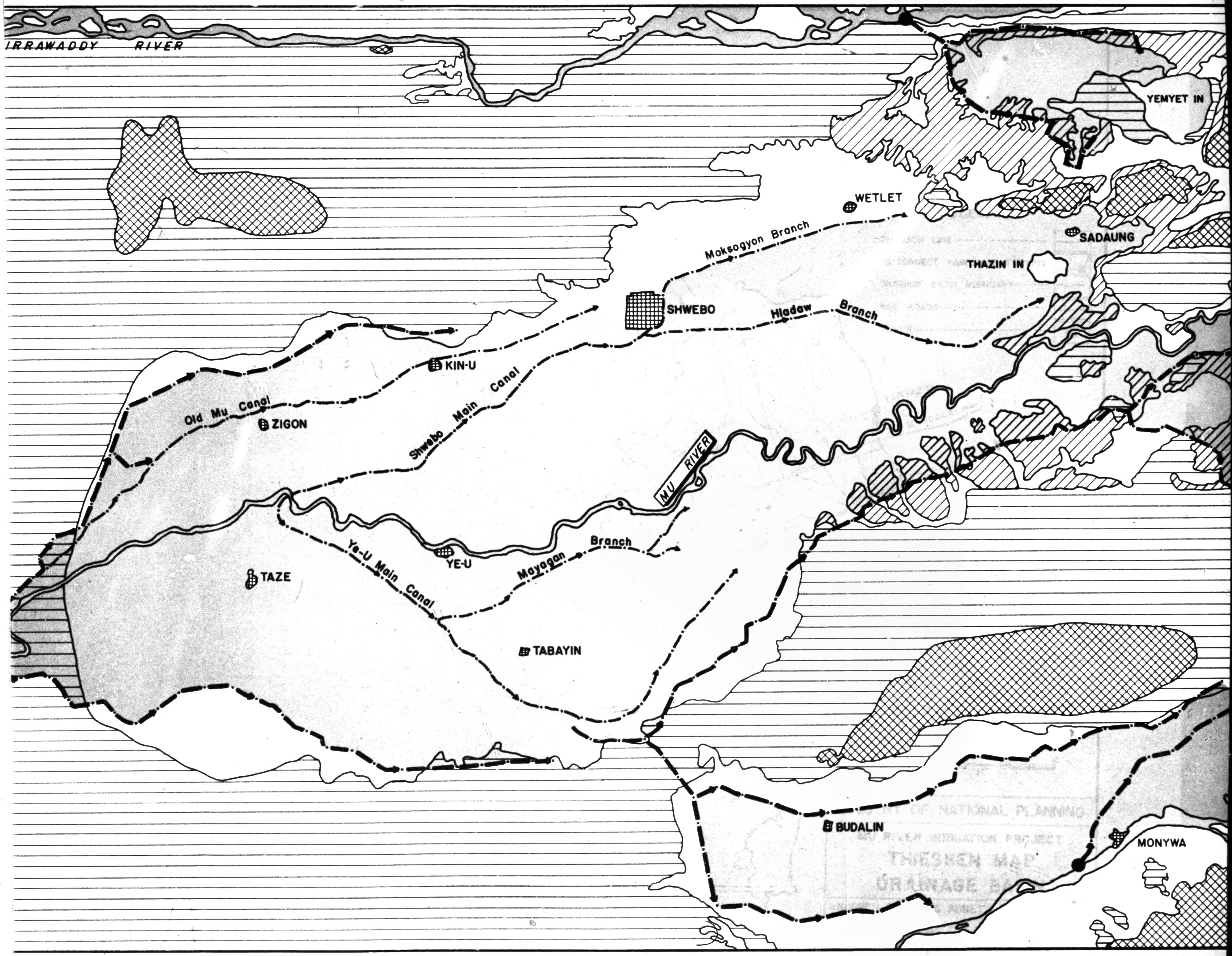
MU RIVER
IRRIGATION PROJECT

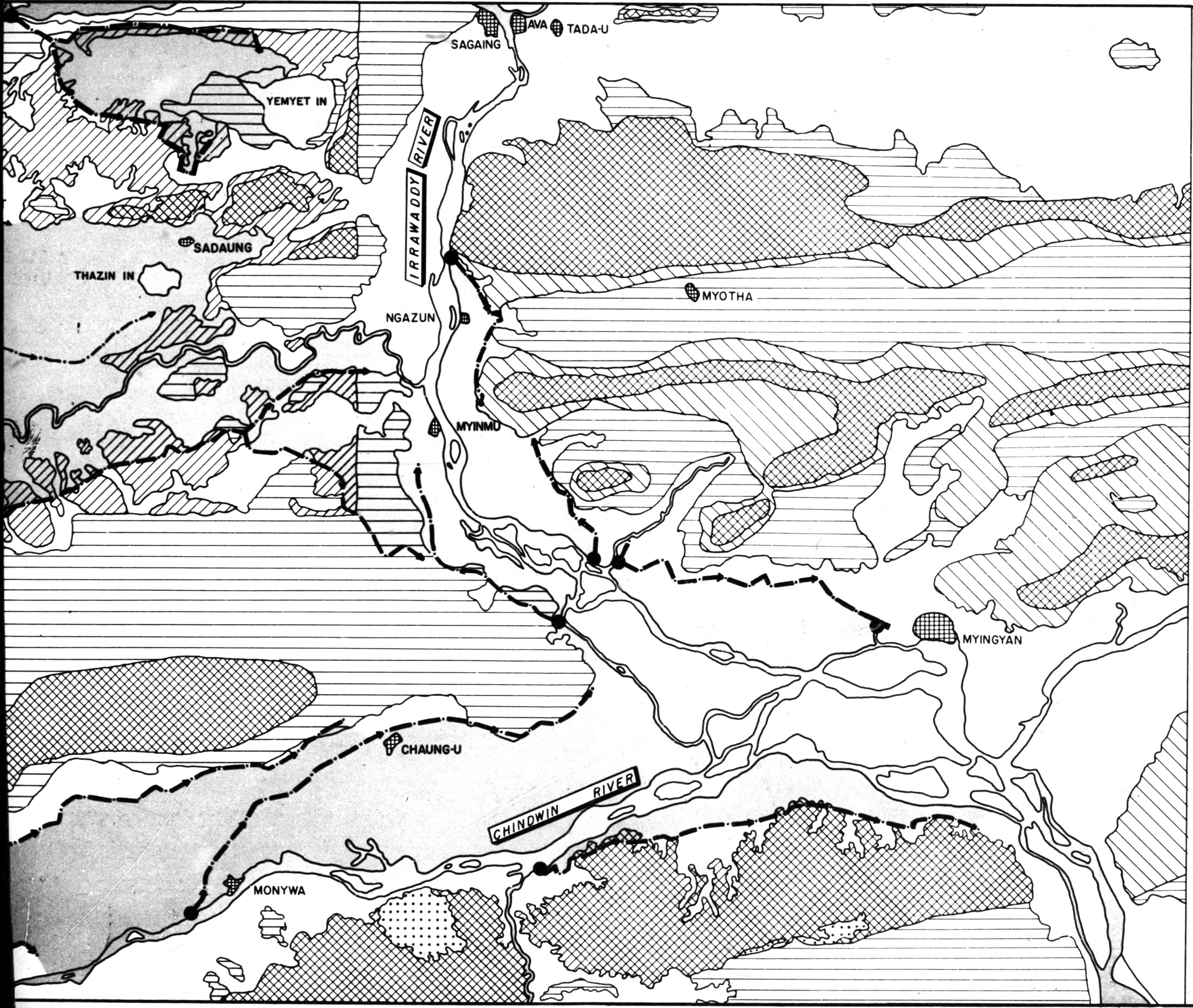
IRRAWADDY PUMP P 7.
NEAR SEIKPYU.

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. EJP DATE MAY. 53.
CK. BY. ARR
PLATE NO. 14a


IRRAWADDY RIVER
RESERVOIR
WETTO DAM
KYUNHLA DAM
KYUNHLA
YABIN CHAUNG
Old Mu C


IRRAWADDY RIVER
YEMYET IN
WETLET
SADAUNG
THAZIN IN
Moksogyon Branch
SHWEBO
Hladaw Branch
KIN-U
Old Mu Canal
ZIGON
Shwebo Main Canal
MU RIVER
YE-U
Mayagan Branch
Ye-U Main Canal
TAZE
TABAYIN
BUDALIN
MONYWA
BOARD OF NATIONAL PLANNING
MU RIVER IRRIGATION PROJECT
THIESSEN MAP
DRAINAGE BA


SAGAING
AVA
TADA-U
YEMYET IN
IRRAWADDY RIVER
SADAUNG
THAZIN IN
NGAZUN
MYOTHA
MYINMU
MYINGYAN
CHAUNG-U
CHINDWIN RIVER
MONYWA

LEGEND

▦	TOWN
▒	PROJECT IRRIGATION
━·━	NEW IRRIGATION CANALS
—·—	EXISTING IRRIGATION CANALS
●	PUMP
☐	ALLUVIUM
▤	IRRAWADDIAN SERIES
▩	PEGU SERIES
▧	PASSAGE BED SERIES
▨	PLEISTOCENE
⁙	UNCLASSIFIED CRYSTALLINE

SCALE IN MILE

MILES 4 2 0 4 8 MILES

MINISTRY OF NATIONAL PLANNING

MU RIVER
IRRIGATION PROJECT

GEOLOGICAL MAP

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
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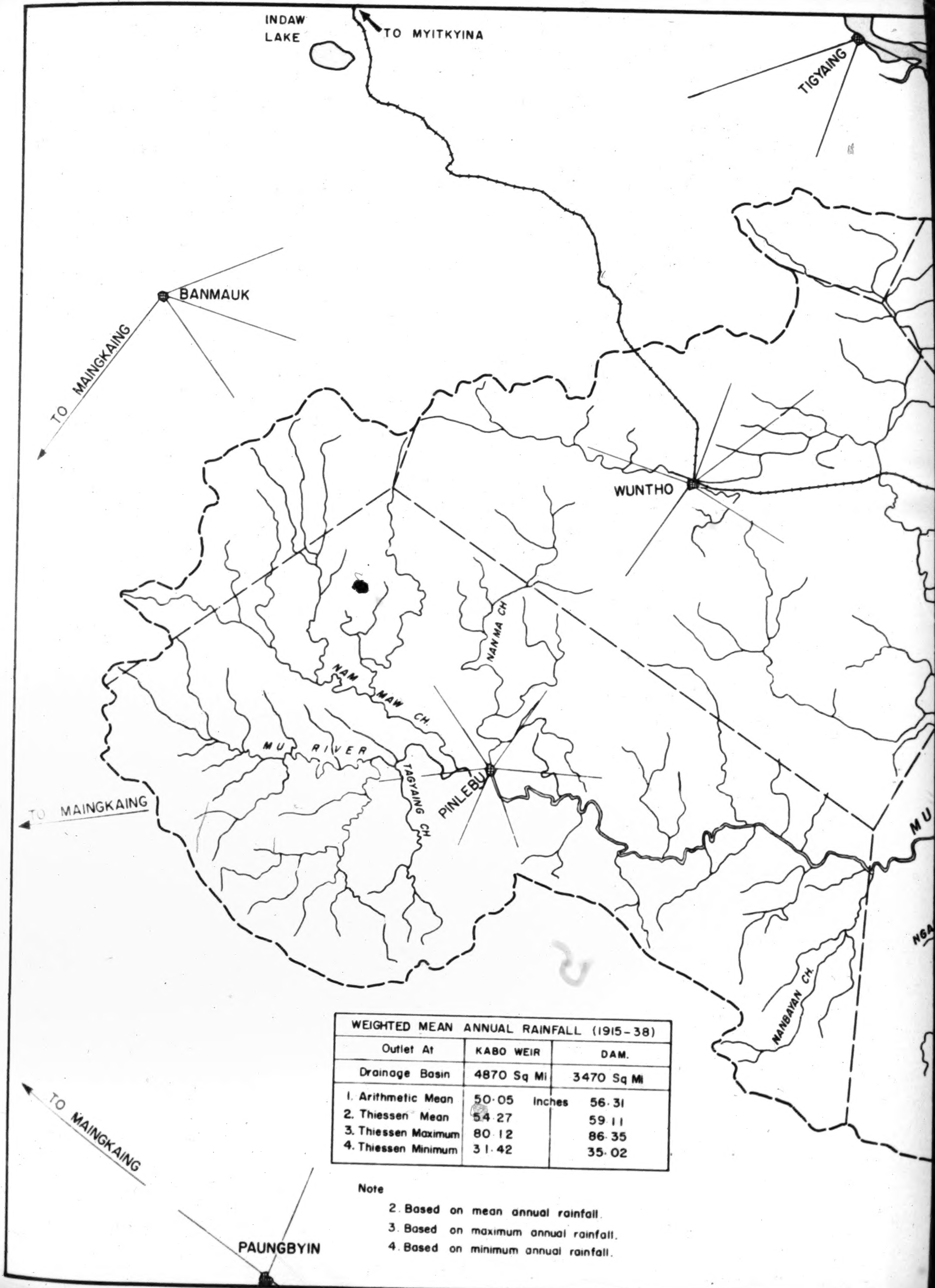
DR. BY. E.J.P. DATE PLATE NO. 15
CK. BY. A.R.R. MAY. 53.


INDAW LAKE
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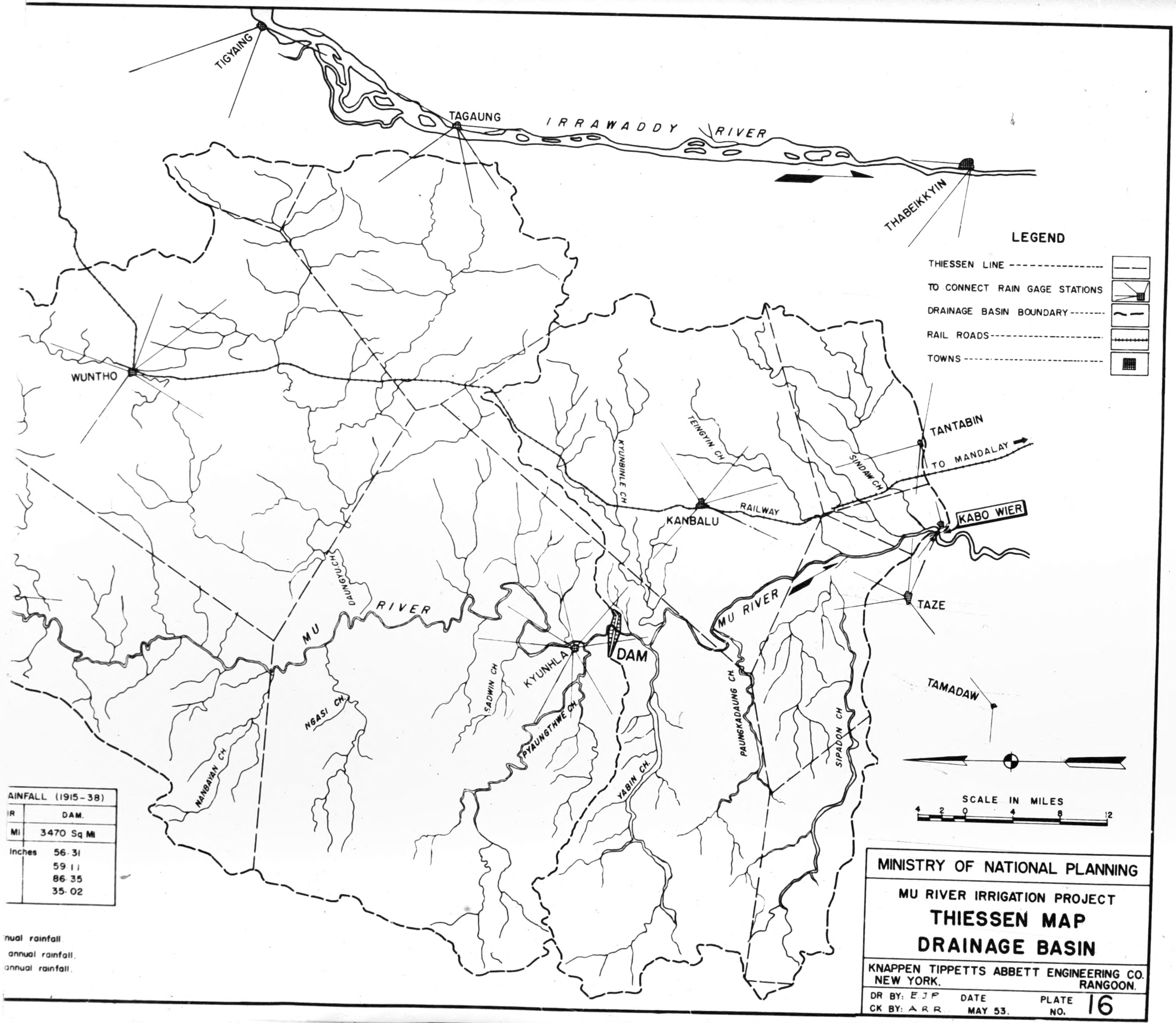
TAGYAING CH
PINLEBU
TO MAINGKAING
MU
NGA
NANBAYAN CH.
TO MAINGKAING
PAUNGBYIN

WEIGHTED MEAN ANNUAL RAINFALL (1915-38)		
Outlet At	KABO WEIR	DAM.
Drainage Basin	4870 Sq Mi	3470 Sq Mi
1. Arithmetic Mean	50·05 Inches	56·31
2. Thiessen Mean	54·27	59·11
3. Thiessen Maximum	80·12	86·35
4. Thiessen Minimum	31·42	35·02

Note

2. Based on mean annual rainfall.
3. Based on maximum annual rainfall.
4. Based on minimum annual rainfall.


TIGYAING
TAGAUNG
IRRAWADDY RIVER
THABEIKKYIN
WUNTHO
TANTABIN
TO MANDALAY
SINDAW CH.
TEINGYIN CH.
KYUNBINLE CH.
KANBALU
RAILWAY
KABO WIER
TAZE
MU RIVER
DAM
KYUNHLA
DAUNGYU CH.
MU RIVER
TAMADAW
SADWIN CH.
PYAUNGTHWE CH.
YABIN CH.
PAUNGKADAUNG CH.
SIPADON CH.
NGASI CH.
NANBAYAN CH.
SCALE IN MILES
4
2
0
4
8
12

LEGEND

THIESSEN LINE
TO CONNECT RAIN GAGE STATIONS
DRAINAGE BASIN BOUNDARY
RAIL ROADS
TOWNS

AINFALL (1915–38)	
IR	DAM.
MI	3470 Sq MI
Inches	56·31 59·11 86·35 35·02

nual rainfall.
annual rainfall.
annual rainfall.

MINISTRY OF NATIONAL PLANNING

MU RIVER IRRIGATION PROJECT

THIESSEN MAP
DRAINAGE BASIN

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
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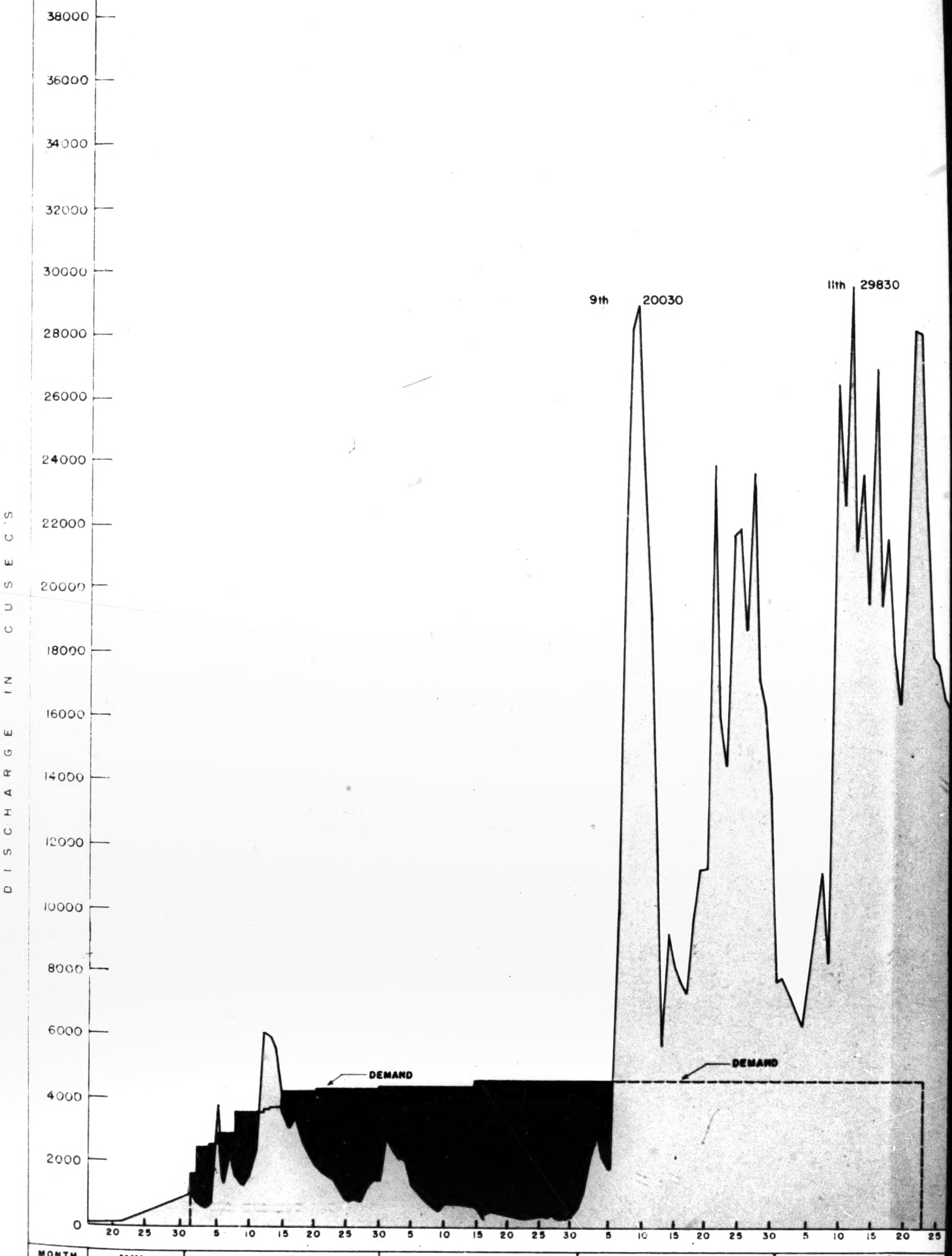
DR BY: E.J.P. DATE PLATE NO. 16
CK BY: A.R.R. MAY 53.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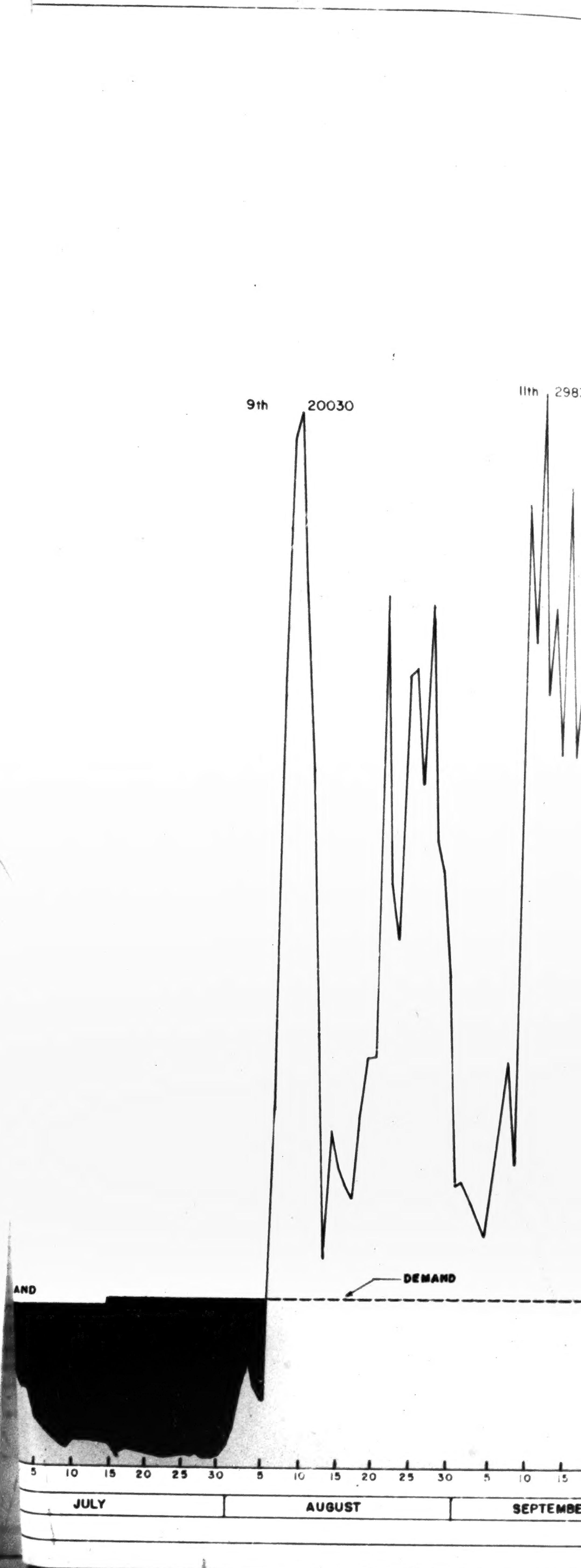
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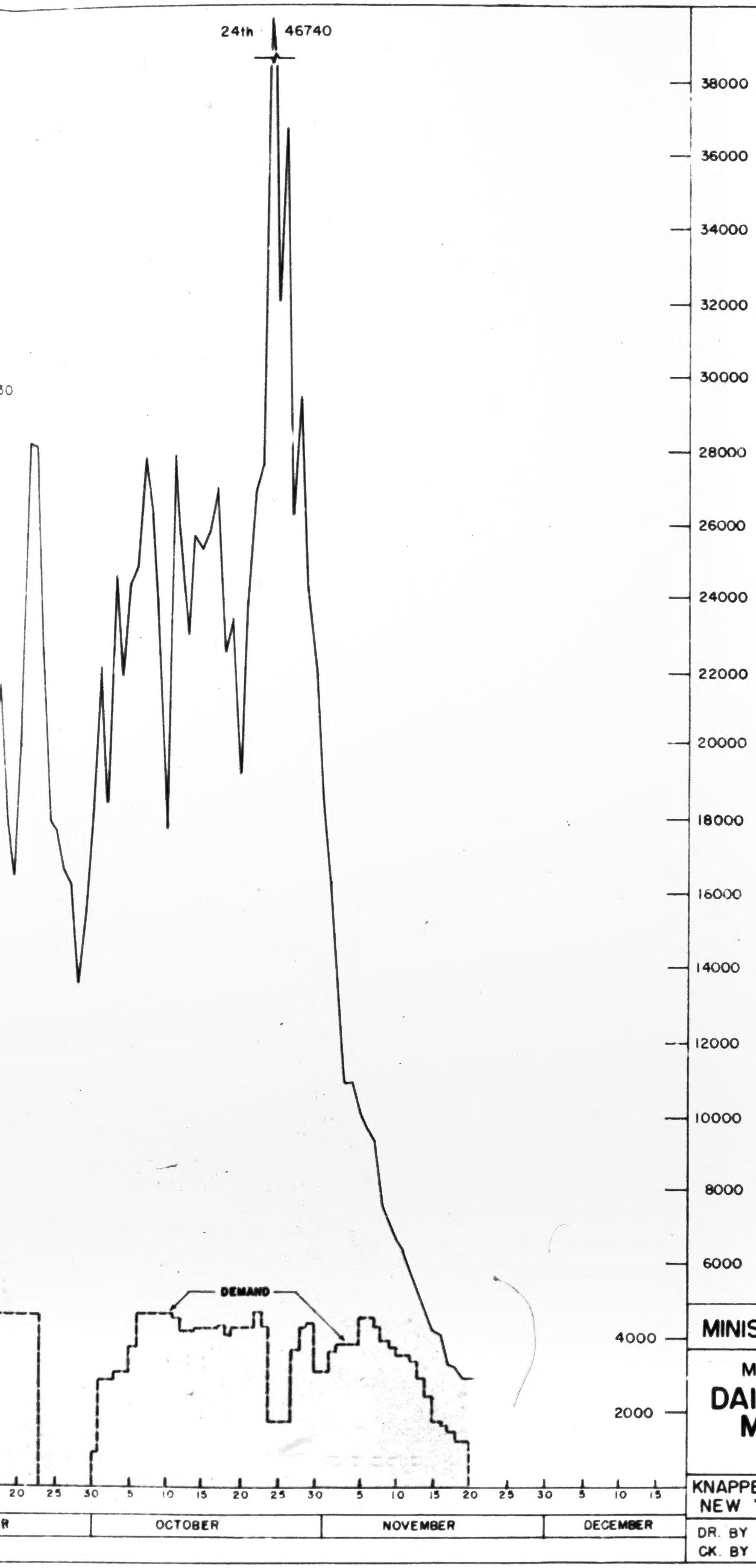


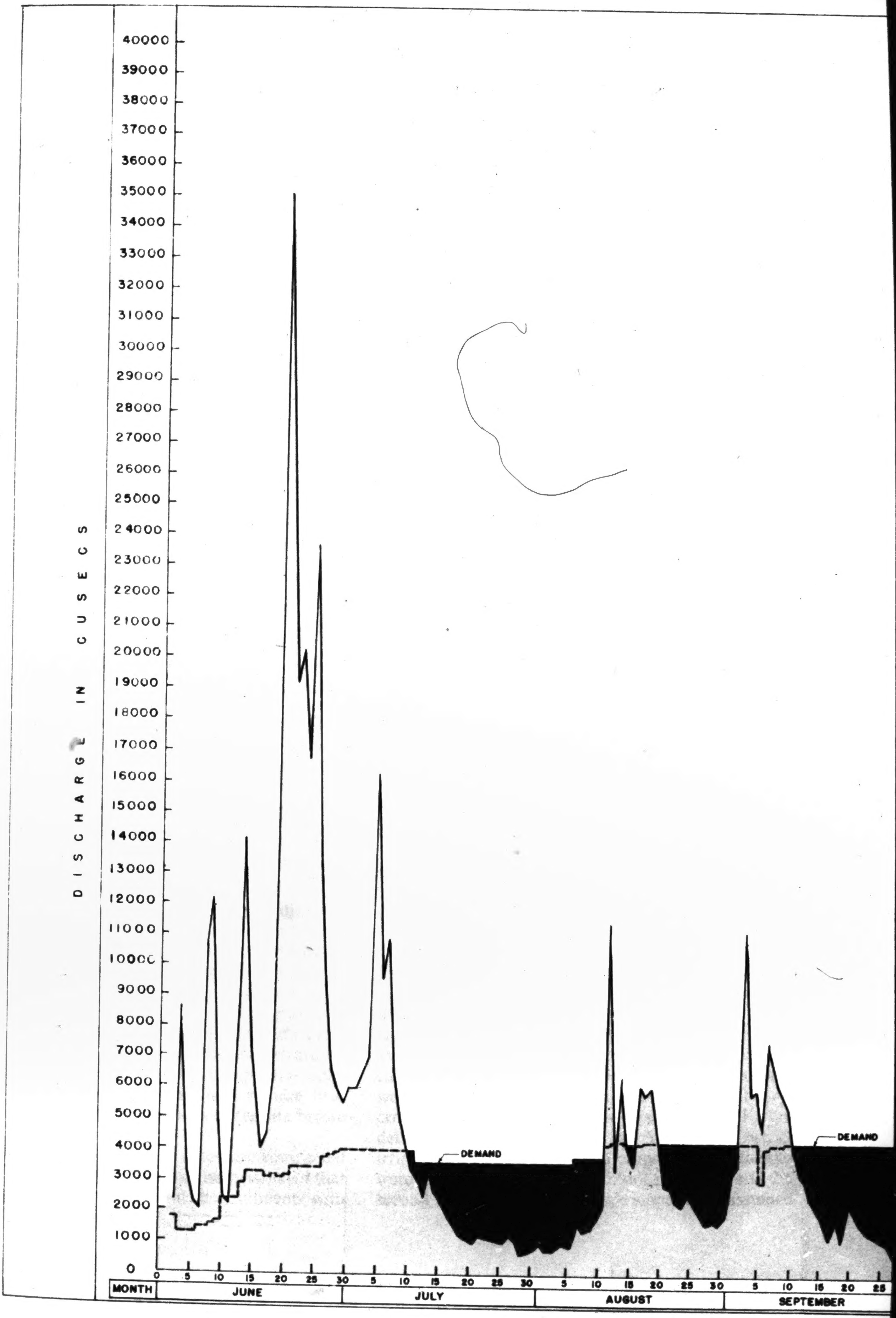
MINISTRY OF NATIONAL PLANNING

MU RIVER IRRIGATION PROJECT

DAILY HYDROGRAPH OF MU RIVER AT KABO 1947

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P.
CK. BY A.R.R.
DATE JULY 53
PLATE NO. 17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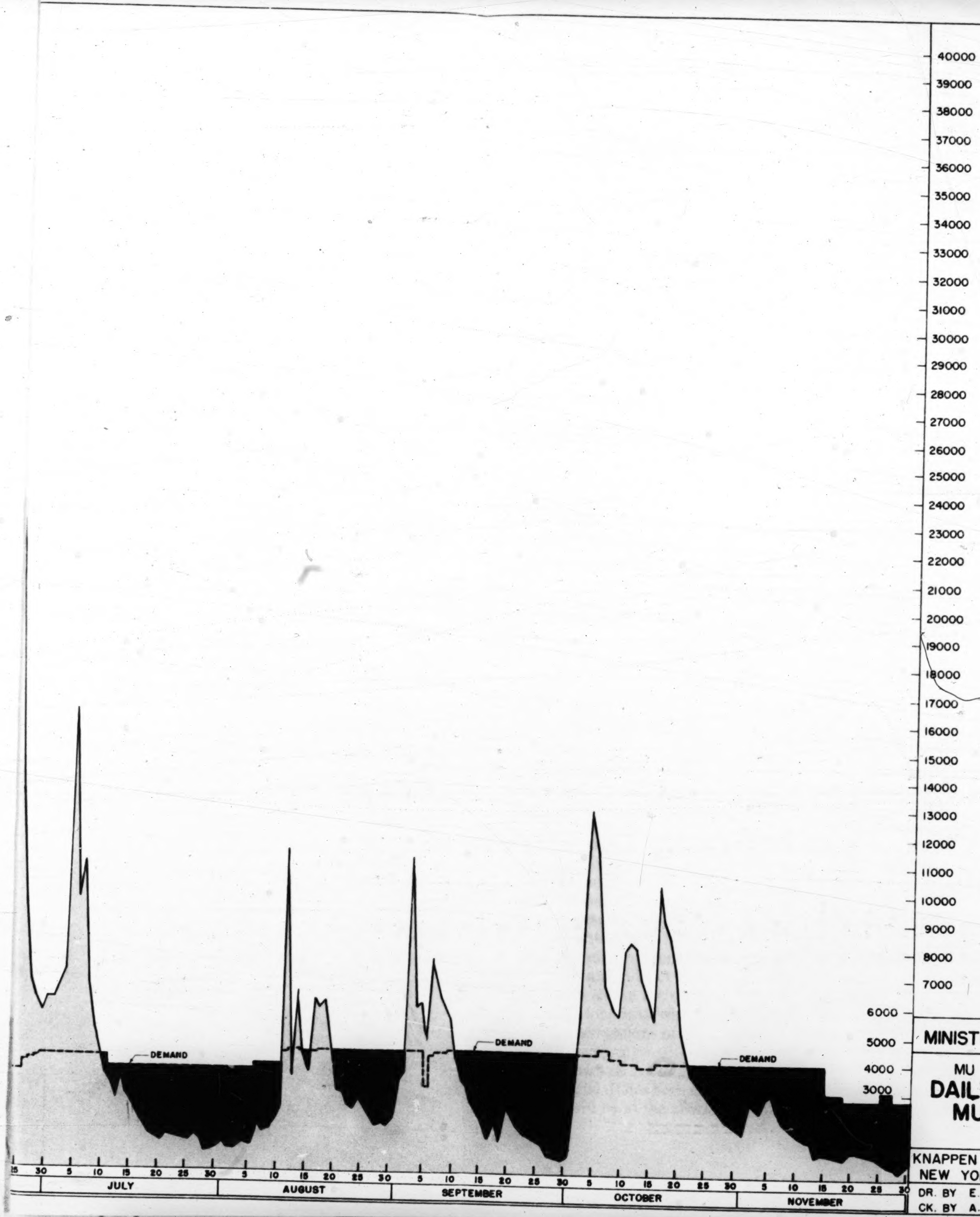


MINISTRY OF NATIONAL PLANNING

MU RIVER IRRIGATION PROJECT

DAILY HYDROGRAPH OF MU RIVER AT KABO 1951

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P.	DATE	PLATE
CK. BY A.R.R.	JULY 53	NO. 18

Field surveys at the Sinthe Chaung, Paunglaung River, Thitson Chaung, Yezin Chaung, Kyeni tank and Kandaw Village dam sites, and limited data on Thongwa Island including stream gauge heights at various stations around the Island. The field surveys are reservoir topography at Yezin Chaung, Paunglaung River, Kyeni tank and Kandaw Village sites and centerline profiles on Sinthe Chaung and Thitson Chaung dam sites.

Working statistics and reports of the existing irrigation system in Burma, in which acreages commanded, acreage irrigated annually, amount of water used and design features are recorded, were used extensively.

Five years of flow records on the Mu River and one year (1952–53) flow records on the Yezin Chaung and Paunglaung River.

Aerial photos at scale of 1 in. = 2,000 ft. on the Kandaw Village, Yamethin irrigation and Mu River irrigation project areas were available at the close of the planning and were used for cursory review and inspection.

Meteorology and hydrology data from the Meteorological Department.

Field reconnaissance trips were made to the areas under the Yamethin District irrigation project, Mu River irrigation project, Kandaw Village irrigation project, Loikaw Area irrigation project, Pakokku pump irrigation from wells, Buthidaung Area irrigation development, and a portion of Thongwa Island and the location of Meiktila Lake. Dam sites were inspected on the Sinthe and Yezin Chaungs, Paunglaung River, the Mu River at Kabo and Kandaw Village. The Shwebo, Ye-U and Old Mu Canals were inspected in operation. Farm practices were viewed and much useful data and knowledge were gained from conversations with local officials and their assistants.

(3) Preliminary Designs

All of the structures have been standardized as much as possible for all the projects. Each development location, however, has special features related to the particular conditions found at the site or suggested by previous reports or descriptions of the area. All details of design were assumed in accordance with recognized good engineering and construction practice. The cost estimating and project layouts are on this basis, and any details shown are suggestive only. All structure and canal locations will require field surveys and complete investigations of the site before the preparation of design plans.

All dams except as otherwise noted are compacted earth fill of selected material. It has been assumed that the initial construction will be at the abutments with the central closure made during the following "dry season." A temporary diversion dam upstream of the main dam will divert the stream flow through a conduit under the embankment. The conduits will remain in place after construction for incorporation in the outlet structure.

The spillway structures are all of the reinforced concrete chute type, located either at a natural saddle from the reservoir area or in a cut constructed at one of the abutments of the dam. Except at the locations where log sluicing is to be provided or the spillway is gate controlled, the sills are at the same elevation as the normal water surface (NWS) of the reservoir. Additional height is provided on the dam to accommodate the water depth over the spillway sill for the discharge capacity required at each location.

Irrigation canal headgate structures are used for the release of water to the canals only where the water level at the supply is nearly constant. Outlet structures for release of water to canals from reservoirs are conduits through the dam embankment near the stream bed elevation with gates controlled in a tower rising from the conduit invert to the top of the dam. It has been assumed that the conduits will be installed in an excavated trench which will be back filled with compacted layers of earth fill similar to the dam embankment. The outlet conduit of all tower outlet structures will be used initially for temporary diversion of stream flow during construction. The intake structures of the conduits will be provided with trash racks.

Several flumes are required as noted on the general plans for the specific projects. These are steel and similar to the Lennon type steel flume manufactured by the Armco Company. The sub-structure will be local timber.

Culverts and siphon culverts are planned at all highway, railroad, secondary road and stream crossings. They may be either reinforced concrete precast conduits, steel conduits, or formed and poured box type culverts.

The pumps at all installations are turbine type, designed to meet requirements of the particular location.

Canals, canal structures and outlet works are designed to deliver one foot of water per acre to the land in any single month operating continuously on an average of 20 hours per day, with an increase in capacity of 40% to cover all losses. The maximum water requirement per one month of the total for a crop period is one foot. This was determined from detailed studies made for the Yamethin District irrigation project on soils and crops. Canal velocities were established at 1·0 second foot minimum and 2·5 second feet maximum. $1\frac{1}{2}$:1 side slopes were assumed for all earth canals except for spillways which were assumed as 1:1.

c. Agriculture

An agricultural program planned for maximum benefits is essential under an irrigation development program to justify the high capital expenditures. The program will include many details related to full use of the land potential. It will utilize all the basic agricultural resources such as climate, soil, topography and water and the human element engaged in the various agricultural pursuits.

The present land use should be considered in relation to the improvements that may be possible because of the project. This will include particular techniques, labor and size of holdings. To make the necessary studies, production statistics must be available. General soil information was obtained from the limited agricultural literature available in Burma. Settlement records provide general information on crops and soils. "An Economic Classification of Land in Burma" by J. T. Sanders and U Ba Tin provides information of crops and yields for the five-year period ending June 1940 and helps to determine relative productivity of the areas.

Increases of agricultural production under irrigation projects will be possible not only from irrigation but also from intensive cultivation and the use of fertilizer, farm mechanization, improved farm implements and simple techniques (Chapter VIII). The provision of irrigation will result in increases in production by addition to the cultivated acreage of lands now left fallow or abandoned because of crop failures, and by double cropping as recognized under intensified agriculture.

It may be necessary to adopt special procedures to inform and educate the farmer, not only in improved cultivation techniques but also in the proper use of irrigation water. This can be done by establishing demonstration farms for the purposes of demonstrating production potential, methods and costs, and of providing research and training.

Classification of soils is essential in the establishment of an agricultural program (Chapter VIII). Classification is based on the soil profile, surface texture, slope and other characteristics. This information applied to known areas is the basic information on which the crop rotation program is planned for maximum benefits. A realization of the full farm land potential should be the ultimate goal under any project, and this can be achieved only by modern farming and a two-crop-per-year program.

In the studies to determine the possible benefits from each of the project developments, three classifications of cultivation methods as described in detail in Chapter VIII of this report were considered. These are as follows:

(1) Present methods, referring to present operational methods used in Burma.

(2) Present methods with irrigation, referring to present operational methods in Burma supplemented by improvements brought about by irrigation under the project.

(3) Modern methods with irrigation, referring to operational methods in conjunction with mechanization use known to be applicable to particular farm operations.

It is realized that cultivation will continue by present methods over most of the project areas for many years but considerable benefits will result in the proper use of sufficient irrigation provided by the project. Additional benefits derived from modern methods will depend on the rate at which they are accepted.

B. SPECIFIC PROJECTS

Those projects scheduled for "Early Implementation" under the future irrigation development program have been studied in detail, and field surveys were made where security permitted.

The source of the water supply and its use distribution is shown in Table IX–7 for the Mu River irrigation project; Table IX–11 (*see p.* 220) for the Yamethin District irrigation project; and Table IX–17 (*see p.* 236) for the Kandaw Village and Loikaw Area irrigation projects. These tables list for each project natural water resources to be developed for the irrigation water supply, the distribution of the developed supply, and the land to be served under each developed source.

Not all of the gross acreage listed in column 12 is suitable for irrigation, because of topographic features such as roughness of terrain, high areas and streams, and the villages and roads. Column 13 is a percentage of the gross, ranging from 70% to 90% representing the acreage to be irrigated and the basis for the water distribution. This percentage estimate of land suitable for irrigation is based on field inspection and map study. Column 14 is the land that is estimated as requiring irrigation under a second crop during the dry season. This is assumed at 75% of the land listed in column 13. The balance of the land cultivated in the second crop season is assumed as a non-irrigated crop. The water distribution is made on the basis of one foot per acre for supplement during the rainy season crop period on all the acreage listed under column 13, and the balance of the available supply, up to a maximum of three feet per acre, for the second crop acreage listed under column 14. Water requirement studies based on soil analysis and crop rotation plans for the Yamethin District irrigation project area have

TABLE IX 7

MU RIVER IRRIGATION PROJECT

WATER SUPPLY AND USE DISTRIBUTION

1	2	3	4	5*	6	7	8	9	10
Source	Drainage Basin				Reservoir Storage (acre feet)				
	Area (sq. mi.)	Annual Ave. Rain (inches)	Est. Ave. Runoff (per cent)	Est. Ave. Yield (acre feet)	Use Provision	Capacity	Evaporation Loss	Dead Storage	Net Available for Irrig.
Mu River	3470	59·11	30	3,290,000	Reservoir	3,200,000	380,000	50,000	2,860,000

11	12	13	14	15	16	17	18
Location : Refer to General Plan	Land to be Served			Water Distribution (acre feet)			Remarks
	Gross Acres	Net Acres Irrigated	Net Acres 2nd Crop	1st Crop Supplement	2nd Crop Total Irrig.	Total	
Old Mu Canal	85,500	68,700	51,500	68,700	154,500	223,200	Existing Rehabilitated
New Mu Canal	66,331	52,800	39,500	52,800	118,500	171,300	
Shwebo Canal	264,129	211,500	158,500	211,500	475,500	687,000	Existing
Ye-U Canal	145,482	116,500	87,500	116,500	262,500	379,000	Existing
West Side Canal	228,000	182,500	137,000	182,500	411,000	593,500	
Monywa District and West Branch	142,208	114,000	85,500	114,000	256,500	370,500	
East Branch	169,200	118,500	89,000	118,500	267,000	385,500	
Total	1,100,850	864,500	648,500	864,500	1.945,500	2,810,000	
Chindwin River							
Canal P.1	137,600	103,000	77,200	103,000	231,600	334,600	Chindwin Pump P.1
Canal P.2	28,800	21,600	16,200	21,600	48,600	70,200	,, ,, P.2
Total	166,400	124,600	93,400	124,600	280,200	404,800	
Irrawaddy River							
Canal P.1W and P.1E	47,100	37,700	28,300	37,700	84,900	122,600	Irrawaddy Pump P.1
Canal P.2	12,800	10,300	7,700	10,300	23,100	33,400	,, ,, P.2
Canal P.3	20,500	16,400	12,300	16,400	36,900	53,300	,, ,, P.3
Canal P.4	6,400	5,100	3,800	5,100	11,400	16,500	,, ,, P.4
Canal P.5	16,500	12,400	9,300	12,400	27,900	40,300	,, ,, P.5
Canal P.6	19,200	14,400	10,800	14,400	32,400	46,800	,, ,, P.6
Canal P.7 (Seikpyu)	19,250	13,500	10,100	13,500	30,300	43,800	,, ,, P.7
Total	141,750	109,800	82,300	109,800	246,900	356,700	

***The yield of Mu Tributaries between Storage Reservoir and Kabo Diversion is not considered.**

established this average distribution as sufficient to cover the crop demand and all losses from the reservoir to the growing plant.

The water supply is based on drainage basin yields with average rainfall. Should there be years of rainfall below this average, adjustments will be required in the acreage served or the crop plan, so that the total water requirements will equal the supply. The estimate of the runoff is conservative because the rainfall is based on valley records rather than the higher rainfall in the mountainous areas of the drainage basins. The flexibility of the water distribution as planned justifies the water use.

The estimated capital cost, annual charges, and benefits for all but the last four Far Future projects, are shown in Table IX–19 Part C of this report (*see p.* 242).

1. MU RIVER IRRIGATION PROJECT

The over-all development of the Mu River irrigation project is shown on the General Plan Plates 11 to 14a inclusive. This plan shows the dam and reservoir locations at Wetto and Thapanseik, the canal locations and areas in acres served under each canal division, the existing canal systems from the Kabo headworks, areas for pump irrigation and the locations of the pumps on the Chindwin and Irrawaddy Rivers, and the general topography and other physical features of the entire area to be developed under the project. Plate 14a is for the Irrawaddy pump P.7 near Seikpyu only.

a. Present Economy

The area that will receive agriculture production benefits through gravity irrigation from the project is in Shwebo, Sagaing and Lower Chindwin Districts. The areas under the river pump installations are in Sagaing, Lower Chindwin, Myingyan, Minbu and Pakokku Districts. The project development by districts with acreage and estimated population is shown in Table IX–8.

The project area is principally agricultural; most of the population is engaged in farming or dependent on agricultural production. The population density is low, that of Sagaing and Myingyan Districts being the highest. The only towns of any size in the project area are Shwebo in Shwebo District with a population of 17,827, and Monywa with a population of 26,279 on the border of the area under the Monywa Distributary and West Branch and Chindwin pump P.1. Pakokku town with a population of 29,824 is not in the project area but will benefit from Chindwin pump P.2 installation in addition to the improved economic situation brought about by the over-all development on the Chindwin and Irrawaddy Rivers. All industries are related to agricultural produce except for the silver craft, weaving and fishing.

Complete agricultural development under the project program will require changes in cultivation and labor procedures. The low population of the area, indicated in Table IX–8, will make possible the resettlement of farmers from land areas with poor production. The rainfall, 25 to 40 inches over all of the project area, is very low, and, even with present irrigation, moisture is often deficient at the beginning of the crop season. Plates 17 and 18, showing stream flow on the Mu River, indicate the uneven distribution and deficiency of rainfall as represented by stream flow and demand curves.

TABLE IX – 8

MU RIVER IRRIGATION PROJECT
PROJECT DEVELOPMENT DATA

Project Unit	*Area under Irrigation*		
	District	*Acreage*	*Estimated Population*
Old Mu Canal	Shwebo	85,500	38,400
New Mu Branch	,,	66,340	30,000
Shwebo Canal	,,	264,130	119,000
Ye-U Canal	,,	145,480	65,500
West Side Main Canal	,,	228,000	102,500
East Branch Canal	,,	56,400	25,400
,, ,, ,,	Lower Chindwin	56,400	19,200
,, ,, ,,	Sagaing	56,400	21,400
Monywa Distributary West Branch Canal	Lower Chindwin	142,200	48,300
Irrawaddy Pump P.1	Sagaing	47,100	16,000
,, ,, P.2	,,	12,800	4,400
,, ,, P.3	,,	20,500	7,000
,, ,, P.4	,,	6,400	2,200
,, ,, P.5	Myingyan	16,500	6,500
,, ,, P.6	,,	19,200	7,500
,, ,, P.7	Minbu	19,250	9,400
Chindwin Pump P.1	Lower Chindwin	23,000	7,800
,, ,, P.1	Sagaing	114,600	43,500
,, ,, P.2	Pakokku	28,800	12,700
Total Under Gravity System		1,100,850	469,700
Total Under Pump Systems		308,150	117,000

Several thousand acres of arable land not under cultivation are known to exist in all the districts in which the project is located. The acreage left fallow, replanted, and abandoned each year because of moisture deficiency is very high. Table IX–9 shows principal crops and acreage for each, per cent of total cultivated land sown, fallowed, replanted, or replaced and abandoned, and gross production income per acre for each district. These data are based on prewar production records converted to present prices. The gross average production income per acre sown is very low. The acreage cultivated per family must be higher than in other areas to provide a living income.

TABLE IX – 9

MU RIVER IRRIGATION PROJECT
CULTIVATION AND PRODUCTION DATA

(thousand acres sown over entire district)

District	*Shwebo*	*Sag-aing*	*Lower Chind-win*	*Mying-yan*	*Pako-kku*	*Minbu*
Product						
Rice	531·0	40·6	73·9	39·7	79·0	139·5
Groundnuts	31·8	32·7	34·6	234·8	192·3	—
Pulses	62·6	187·1	170·0	165·5	23·1	56·9
Sesamum	49·6	86·5	148·7	163·4	46·9	54·4
Millet	0·5	31·9	108·8	108·7	102·9	31·5
Maize	1·0	1·0	5·6	6·0	30·2	18·1
Cotton	7·2	114·6	63·2	65·0	—	1·2
Tobacco	0·7	6·4	2·3	0·9	10·3	2·7
Fruit, veg., etc.	9·3	5·2	6·5	8·3	2·0	3·2
Per cent						
Sown	69	73	67	66	71	63
Fallow	31	27	33	34	29	37
Replanted	5	10	13	14	10	12
Abandoned	10	24	12	8	16	8
Gross Income						
K/Acre	42·22	28·30	28·88	27·27	37·22	48·54

The average gross production income per acre for all of Burma is K71·03. Even with this low average, the divisions in which the project is located are much lower.

The project will bring into cultivation some of the arable land not now cultivated, eliminate the necessity for the fallow acreage, provide a guaranteed water supply when needed to eliminate the sowed acres which are abandoned, and provide uniform water applications, thus increasing the production per acre as well as the over-all production from increased acreage and from second cropping during the dry season.

b. Geology

The Mu River irrigation project is located entirely within the physical division of Burma known as the Central Belt, lying between the Shan Plateau division on the east and the Fold Mountain Belt division on the west These divisions run from north to south through the entire length of Burma.

The Central Belt was the last of all the divisions to become dry land, being previously occupied by the sea and called the "Burmese Gulf." After silting-up, the site of the gulf was occupied by the lower course of the Irrawaddy River. The Central Belt is built up entirely of tertiary river-borne sediments brought down from the north by the ancestors of the present Irrawaddy and Chindwin Rivers. Marine fossils have been found as far north as the latitude of Monywa in the Shwebo district, indicating that the mouth of the river cannot have been far south of that locality.

The Mu River, flowing from north to south through the center of the project area, is one of the main tributaries of the upper Irrawaddy. It flows through an alluvium-covered basin following the course determined by the direction of the mountain trend. The river channel is wide and shallow after emerging on to the plain area from the low hills near Wetto. The deposits are principally fine sand and mud.

Two geological soil formations make up most of the valley composition. They are known as the Irrawaddian and Alluvium Series and overlie the older formation of the Pegu Series. Plate 15 is the Geology Map for the Mu irrigation project area.

c. Local Natural Conditions

(1) Meteorology

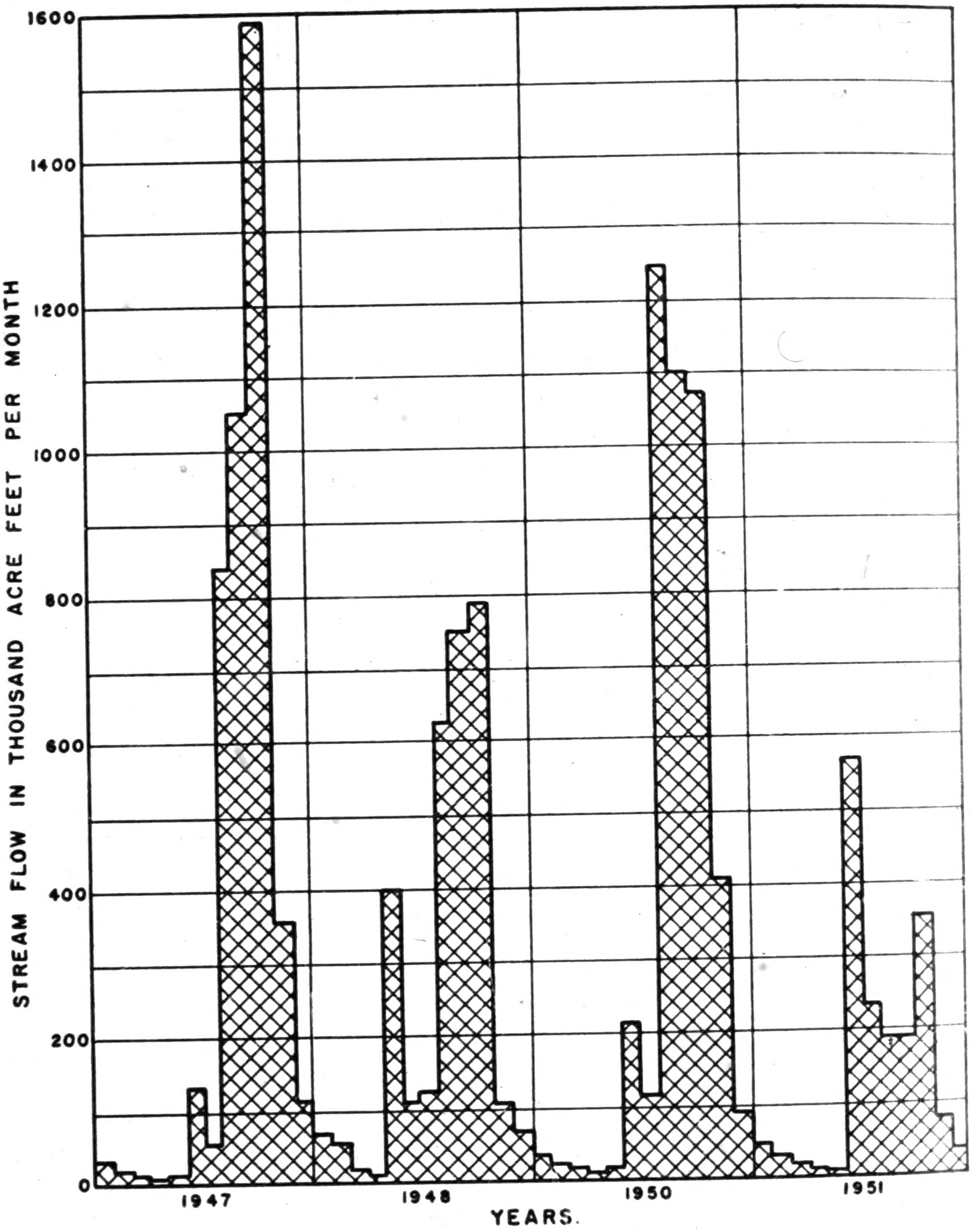
The southwest monsoon carries a considerable amount of humidity from the Bay of Bengal, resulting in the wet weather from mid-May to mid-October. These winds lose most of their moisture as they cross the Arakan and Pegu Yomas. This factor produces the Dry Zone in Central Burma, in which lies the Mu River irrigation project. However, about one third of the drainage area for the Mu River is within the Northern Hills region which has a higher rainfall than the Dry Zone.

The southwest monsoon current, after crossing the Arakan and Pegu Yomas, strikes the Shan Hills and changes its direction to southeast, accounting for the southeast current in the project area. About the beginning of November the monsoon moves from southwest to northwest. This movement of the lower currents of the southwest monsoon from Central Burma is followed by the dry northerly land winds which continue until the southwest monsoon returns with its moisture from the ocean.

The only temperature station in the project area is at Monywa. The records cover a period of 47 years. The monthly range between maximum and minimum temperatures is a maximum of 29·9° F. in March and a minimum of 14·1° F. in August. The mean monthly range for the year is 20·8° F. The mean daily minimum of 57·1° F. is in January and the maximum of 101·8° F. is in April. Since evaporation is definitely influenced by temperature ranges, the characteristics of this cycle indicate the rate of evaporation.

The normal relative humidity data at the Monywa station cover a period from 1901 to 1940, with recordings at 9.00 and 18.00 BST. The maximum relative humidity occurs at the 9.00 recording with a mean annual over the 41 years of 72%; and the minimum relative humidity occurs at the 18.00 recording with a mean annual over the 41 years of 59%. The minimum relative humidity occurs during March which implies that the maximum of evaporation during March agrees with the maximum temperature occurring in April.

Since moisture transpiration is dependent on air movement, precipitation and reservoir evaporation are affected by the winds. The maximum mean



RUNOFF FACTOR OF MU DRAINAGE BASIN

Drainage Area = 4870 Sq. Mi.

YEAR	WEIGHTED RAINFALL INCHES	MILLION ACRE FEET		RUNOFF PERCENT
		TOTAL FLOW	STREAM FLOW	
1947	40·00	10·4	4·18	40·2
1948	46·20	12·0	3·10	25·8
1950	38·80	10·1	4·34	42·9
1951	38·20	9·9	1·75	17·7

MINISTRY OF NATIONAL PLANNING

MU RIVER
IRRIGATION PROJECT

HYDROGRAPH OF MU RIVER AT KABO WEIR

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON
DR. BY E.J.P DATE
CK. BY ARR JUNE, 53.
PLATE NO. 19

monthly wind speed record at Monywa for an average of 24 hours is 3·9 miles per hour in July, for a 38-year period. Rainfall data of record suggest that the maximum rainfall occurs around August. The maximum wind speed for a shorter period, which is much higher than the mean wind speed, is estimated to be about 20 miles per hour.

Measured evaporation data are not available in Burma, but with the natural weather conditions known, the amount was computed by the use of Meyer's formula which has been proven by comparison with measured records as giving applicable results. The computed evaporation for the project area gives a total for the year of 51·8 inches with a maximum in April of 9·24 inches and a minimum in December of 1·75 inches. This agrees very closely with the 48 inches suggested by various writers for reservoir evaporation in the Dry Zone of Burma and with actual measurements recorded in India.

(2) Hydrology

There is a definite lack of these data sufficient in detail, period length, and at the proper location, to make correct evaluations and conclusions as required. The rainfall data available for the project area are from 12 rain-gauge stations of which but six are within the drainage basin of the Mu River. The six stations within the basin control about four-fifths of the total drainage area. These data may not fully represent the exact precipitation conditions within the drainage basin because of the station locations.

The cyclic variation in increase and decrease in rainfall was determined by plotting progressive five-year means curves for all but three of the stations, from which peak rainfall and corresponding intervening periods were tabulated. These data suggest that the rainfall indicated in the drainage basin of the project area could be classified under a five-year cycle.

A map of the project area showing the drainage basins, the Theissen polygons, the rain-gauge stations, and the tabulations of the values for extreme maximum and minimum annual rainfall computed by the Theissen method, and the mean annual rainfall computed by both methods is shown on Plate 16. Maximum 24-hour rainfall for each month at Mandalay and Monywa, for periods of 50 and 47 years respectively, show that rainfall equal or exceeding 7·52 inches could occur once in 50 years at Mandalay and 7·66 inches once in 47 years at Monywa. Since neither of these stations is in the drainage basin above the storage reservoir for this project, the amounts would not be representative of maximum rainfall in the drainage basin but could be used only as a basis for calculations.

Stream-flow data for the Mu River have been recorded at Kabo Weir which is about 38 miles downstream from the Mu River dam site. Records for the years 1946 and 1951 have been plotted and are shown on Plates 17 and 18. These indicate two extreme conditions; one of low flows in the early part of the rainy season and the other of low flows in the latter part of the rainy season. Plate 19 shows a monthly hydrograph of the flow at Kabo Weir for the years 1947, 1948, 1950 and 1951. Each of the records indicates high flows at times when the demand is low, and low flows when the irrigation demand is high.

It is impossible to establish an exact runoff factor from the information at hand because the rainfall data are not available at any of the stations except Kabo for the years for which flow data have been recorded. The runoff factors shown in the table on Plate 19 were computed by supplying the missing rainfall information from weighted rainfall over the basin calculated by the Theissen method based on records at Kabo station. Information on runoff factors corresponding to stream flow of shorter duration is also not available. The runoff factor used for yield estimates is the average for those shown on Plate 19.

The peak flow of record measured at Kabo Weir in the Mu River is 192,000 c.f.s. in the year 1928. Others recorded since 1947 range from 25,970 to 46,740 c.f.s. These records should be quite accurate since the gauging is done on the actual flow at the weir location. Peak flow at the storage reservoir should be lower because of the decrease in drainage area.

d. The Land

The land referred to is that portion of the project area which is to be irrigated under the developed project. Field data for the classification of soils were not obtained because of the insecurity in the area and lack of personnel and time for the necessary laboratory procedure. The background to cultivation studies and general soil information was obtained in the limited agricultural literature on the project area.

Information obtained from settlement reports was compiled as shown in Table IX–10 (*see next page*) for each of the districts except Sagaing, and referenced to location shown on General Soils Data Map, Plate 20. This information, in conjunction with aerial photo studies, is a general basis from which to start a soils classification program for the area. It will also be indicative of the improved cultivation practices that may be introduced to increase production.

General assumptions on production and benefits were based on detailed soil, crop, and cultivation studies made for the Yamethin District irrigation project.

TABLE IX – 10

MU RIVER IRRIGATION PROJECT
GENERAL INFORMATION ON SOILS

Tract	*District*	*General Information* *(crops are listed in order of relative importance)*
1	Lower Chindwin	No information.
2	,, ,,	Inundated silt soil; rich.
3	,, ,,	Red soil; eastern half and southern tongue poor. Silted soil along R.R. line the best. Millet, gram, groundnuts, sesamum and cotton grown.
4	,, ,,	Principally red soil; rocky and infertile in east.
5	,, ,,	Clay soil; best soil is along Thate Chaung. Mostly gram grown.
6	,, ,,	Principally red soil; mostly poor and sandy. Millet, sesamum and groundnuts grown. Along river bank, good soil with tobacco and pulses grown.
7	,, ,,	Hilly; apparently not suitable for agriculture.
8	,, ,,	Cotton tract. Pulses on border of river. Black clays occur at intervals. Upland Yas grow cotton, sesamum and beans.
9	,, ,,	Infertile hard sandy soil predominates with good water-retaining capacity. Toward the south, stretches of clay and bad sand occur. Some alluvial loam near S.E. corner.
10	,, ,,	Red sand; infertile. No silt or black soil. Large tracts of sandy soil of poorest type. Millet and sesamum with some rice in valleys.
7*a*	Shwebo	Flat, fine sandy loam; water is all that is required to produce well.
11	,,	Silt and fine sand. Alluvial sands near river.
12	,,	No information.
13	,,	Essentially fertile but requires lots of water.
14	,,	Clay soil; average to poor except where silt occurs.
15	,,	Not in area.
16	,,	Not in area.
17	,,	Sandy soil and mixed white clay; not very fertile. Deep loam at Indaing. Kwezwe and Kayangyan: superior.
18	,,	Prevailing soil is infertile. Better soil in east part of area but limited in area.
19	,,	Prevailing soil yellow loam with silt. Sand near streams. Proportion of good soils is higher than adjoining tracts.
20	,,	Upland soils stiff red loam with fine sand and some gravel. Black soil with sand or silt on paddy lands.
21	,,	East part is hard sandy soil; deeper and more fertile loams in west and south. Whole tract suited for paddy.
24	,,	Narrow shelf of alluvial land along river and islands.
25	,,	Western portion is level paddy lands.
26	,,	East part is stiff red loam; west soils heavier and darker.
27	,,	Red sandy loam and loose yellow sand.
28	,,	Black cotton soil on lowlands; upland, red and gravely.
29	,,	Rich dark alluvial loam; most fertile in district. Broken and difficult to irrigate.
30	,,	Clay soil; varying somewhat in quality.
31	,,	Clay soil.
32	,,	Clay loam with large particles.
33	,,	Eastern boundary an alluvial strip; other is poor clay with limestone nodules in south.
34	,,	Fertile alluvial soil.
35	,,	Clay with sand and silt; steeply sloped. Heavy soils in lowland but slopes too steep for irrigation.
A	Myingyan	Silt and black loam, small amount of red clay. Millet, sesamum, legumes, groundnuts, and rice are grown.
B	Pakokku	Valley clays, silts and sands; fertile. Paddy, legumes, gram, sesamum, groundnuts, others are grown.
C	Minbu (Seikpyu)	Alluvial clays, silts, and sands; light. Maize.

e. Project Plan

The details shown on the General Plan Plates 11 to 14a inclusive are general; the planning prepared principally by the use of one inch to the mile scale maps with contours at 50-foot intervals, from field reconnaissance, and one-inch to 2,000-feet scale aerial photos. Designs and operation data are available on the existing canals but neither field surveys nor dam foundation investigations have been made on the proposed new units of the development. These will be necessary before contract design plans are prepared.

The water supply and use distribution data shown on Table IX–7 are the basis on which the project has been planned. All the estimated available water supply has been distributed to the land in the proportion required for a two-crop-per-year farm program. Brief details of the complete project development are these:

(1) Storage Reservoir and Dam

The Mu River, carrying water from a drainage basin of 4,500 square miles in the northern hills and valleys of Burma, flows south through a vast agricultural area to discharge approximately 5,800,000 acre feet annually into the Irrawaddy River. The flow at the Kabo diversion works, about 69 miles upstream from the river's mouth, averages about 4,000,000 acre feet annually, 500,000 of which is diverted for irrigation under the present Shwebo and Ye-U canal systems. Plates 17 and 18 show the waste flow and the demand periods when the excess could have been used if available. The dam planned for construction under this project on the Mu River near Thapanseik village, approximately 29 miles north of Kabo, will make possible the storage and control of all the yield from the drainage basin above that point.

The storage reservoir dam will be of compacted, selected earth fill, back of which the stored water will rise to a maximum normal elevation of 550 feet above mean sea level. The lake area thus formed will be about 130,000 acres. The villages and farmers within the reservoir area will be moved to higher ground or resettled within the project irrigation area. The improved land and agricultural facilities available to them because of the project will improve their economic and social conditions far beyond comparison with any loss.

A concrete spillway structure is planned at a natural saddle east of the left abutment of the dam and a concrete tower control outlet structure will make all releases to the river for diversions downstream. Provision will also be made in the outlet works structure design for future hydroelectric installations. The nature of the valley area in which the reservoir is formed makes possible large storage with a dam less than 90 feet high. The dam is the key to the whole project, and would immediately benefit the acreage under the present systems of the Shwebo, Ye-U and Old Mu Canals. The Mu River reservoir and storage dam are the first step in the project development. The present Ye-U and Shwebo canal systems command a gross area of approximately 412,000 acres, 265,000 acres of which now receive supplemental irrigation for the rainy season crop. The entire acreage under the system will be guaranteed a supply of water, not only for the supplement during the rainy season but the total moisture requirement for a dry season crop as well.

(2) Diversion Dam and Old Mu Canal

The Old Mu Canal was discussed under Section A–2–b as one of the existing works. This canal will be rehabilitated from a point where it crosses the railroad southerly to Shwebo, including the old Mahananda tank near Shwebo for the town water supply. The upper end of the canal will be relocated at a higher elevation for service to a new canal above the present Old Mu location.

Originally, the old Mu Canal was supplied by a diversion works at Wetto, about six miles below the proposed reservoir site. The terrain appears to be too difficult for a canal location from the storage reservoir, therefore a new diversion dam is planned for the old site. The dam will impound water at elevation 500 feet, the supply behind the dam being held constant by releases from the storage above. Canals taking off from the diversion works will start with a water surface at about this elevation. Structures for canal service on either side of the river, releases into the river for Kabo diversion, and spillway for flood flows will be included in the diversion works. Facilities for future hydroelectric installations will also be included with this construction.

The construction of the diversion works and the Old Mu Canal system are the second step in the project development. Neither field surveys nor foundation investigations have been made at this time. These will be necessary for preparation of contract design plans.

(3) West Side Canal System

The west side canal system starts on the west side of the river at the Wetto diversion works with 8,760 c.f.s. for service to 540,000 gross acres. The main canal is located approximately on the 500-foot contour to serve the land east therefrom to the Mu River. Dividing into two branches at a point about 30 miles due west of Shwebo, one branch crosses to the west to serve the Monywa area and the other branch continues southeasterly above the Ye-U Canal for additional land as far south as the Irrawaddy River.

Approximately five miles before dividing into two branches, the west side main canal drops into the Minkanbauk Chaung which flows easterly into the Mu River. The canal elevation maintained this far is not required for the lands under the east and west branches. An 80-foot drop is dissipated through a hydroelectric installation with the tailrace wasting to the river via the chaung or fed into the Ye-U Canal which crosses the chaung at this point or picked up by the west side canal at the lower elevation. The tailrace below the power house serves 311,500 gross acres, not including the 41,000 gross acres that could be picked up under the Ye-U Canal at this point. A regulating reservoir will be constructed on the Minkanbauk Chaung above the power house.

Cheap power can be generated at this power installation, and after the completion of the irrigation system from the tailrace south to the Irrawaddy River, the water will be used for irrigation after passing through the power house. The west side canal system is number three in the order of this project development. It may be divided in two parts, however, one the west side main canal including the power installation, and the other the canal system from the power house southward.

(4) Hydroelectric Power

The hydroelectric installations mentioned heretofore are discussed in more detail in Chapter XIX. The total Mu River irrigation project plan is predicated on agricultural development to two crops per year on the total area for use of the entire water supply of the river. This total development will take many years, during which time the water stored in the reservoir could be used for generation of power either at the dam site or at the west side canal site.

The dam for the storage reservoir can be economically justified for a two-crop-per-year program under the Ye-U and Shwebo Canals alone. This requires only 1,066,000 acre feet annually from the 2,800,000 net acre feet in the reservoir. The early hydroelectric potential of the project is very great under these conditions.

(5) Pump Irrigation

The Irrawaddy and Chindwin Rivers are a source of water throughout the year. Areas along their banks are suitable for cultivation on a two-crop-per-year program. Seven pump locations on the Irrawaddy River and two on the Chindwin are shown on the general plan. These installations are all at points topographically suited to support a canal location leading from the installation on the river bank. The installations and acreage commanded are shown in Table IX–7.

Pump No. 1 on the Chindwin River above Monywa may be considered a supplemental supply source after the west side canal system is completed. Although the connection of the west branch canal with the Chindwin Canal P.1 is not shown on the general plans, this will be made just above Kyehmon village. The total acreage under a combination of these two canal divisions is not shown in Table IX–7, but the over-all design is so planned that when the water supply is sufficient the entire area will be irrigated by gravity, and the pump will not be used.

Any one or all of the pump installations could be made at any time, using diesel power or electric power from a steam or diesel source. At such time as the hydroelectric power is available, the power units can be changed over. The pump installation on the Chindwin above Monywa will fit into such a schedule and make possible the irrigation of the area before a gravity canal system from the Mu River is constructed. The pump irrigation from the Chindwin and Irrawaddy Rivers is considered a part of the Mu River irrigation project because of the possibility of using electricity from the Mu River to drive the pumps. Some of the acreage under this pump irrigation was discussed originally in the Preliminary Report under the Pakokku pump irrigation project. The pump installation on the Irrawaddy River near Seikpyu is treated separately because of its isolated position in the project plan. Any one of the pump installations may be considered as a separate project.

(6) Alternative Plan

An alternative plan permits the elimination of the diversion dam at Wetto. This would necessitate the extension of both the west side main canal and the Old Mu Canal up to the storage reservoir site. Map studies indicate these would be very difficult locations and expensive to construct ; however, the saving in cost by the elimination of the duplicate structures required in the two-dam plan may be more than the cost of the canals and canal structures on the relocation. Field surveys will be required before accurate cost estimates for the alternative plan can be made. This study should be made prior to the design and construction of the storage reservoir dam. Plans for field surveys and foundation investigations at the Thapanseik dam site are now being implemented.

2. YAMETHIN DISTRICT IRRIGATION PROJECT

The over-all development of the Yamethin District irrigation project is shown on the General Plan Plates 21 to 23 inclusive. These plates show reservoir locations, capacity at normal water level, water surface elevations at canal origin and other control points, areas in acres served under each canal division, areas for well irrigation, areas for pump irrigation from the Paunglaung River with suggested pump locations, the general topography and other physical features of the whole area. The source of the water supply and its use distribution is shown in Table IX-11 (*see next page*), a detailed explanation of which is found in the third paragraph of Section B.

a. Present Economy

The project area is essentially agricultural with over 50% of the population entirely dependent on farming. Rice is grown on 75% of the cultivated area. Other crops grown are sesamum, maize, pegyi, tobacco, pulses, sugar cane, groundnuts and vegetables. Paddy and timber are exported and cotton goods, kero-oil, cooking oil and salt and provision are imported. There is very little double cropping in the true sense of intensive agriculture. It is not an effective factor in crop production but is done principally to assure the cultivator some kind of a crop return. All records repeatedly state that the chief danger to the welfare of the area is the failure of early rains for the nurseries and initial crop growth, the failure of late rains for maturing, and the uneven distribution of the rainfall.

The agricultural worker is much better off than other workers. It is reported that the average income per agricultural household is approximately K850 per year and that of the non-agricultural household is approximately K510, based on prewar records converted to present prices. In addition to the income from agricultural employment or farm income, some of the workers supplement their income from other pursuits. The average household consists of three adults and two children. The population in the project area is estimated at 610,000 people; 31,180 of whom live in Toungoo, 11,167 in Yamethin and 22,025 in Pyinmana, the three large towns in the area.

Several thousand acres of arable land not under cultivation are known to exist in both districts in which the project is located. Most of the acreage under the project is presently under cultivation but with a very low production per acre. The acreage left fallow and abandoned because of moisture deficiency is very high. Based on prewar production records converted to present prices the gross production income per acre for the Yamethin District is approximately K59·82 and for the Toungoo District K97·16. The average for all of Burma is K71·03. The project will bring into cultivation some of the arable land not now cultivated, eliminate the necessity of the fallow acreage and provide a guaranteed supply of water when needed to eliminate the sowed acres which are abandoned, and thus increase the production per acre as well as the over-all production from increased acreage cultivated.

b. Geology

Two geological soil formations make up the valley composition. They are known as the Irrawaddian and Alluvium Series. The Irrawaddian Series are fluvial sands with fragmentary remains of terrestrial and aquatic vertebrates. The alluvium deposits, which cover about one half the surface area of the Sittang Valley, are partially of older alluvial clay deposits but principally of recent river alluvium. Fossils are not found in the alluvium, and its predominant color is usually a dull grey. Older alluvial clay underlies most of the Delta and lower portions of the valley.

The soil is in composition a very homogeneous, somewhat arenaceous clay of uniform yellowish color, in places assuming a more reddish color than usual, and under certain conditions of exposure and weathering, assuming an imperfect lateritic appearance superficially. It is indicated by a peculiar mottled appearance of the rock caused by the irregular manner in which the peroxide of iron occurs. The whole deposit is very homogeneous, a little more sandy in some places than in others, and with occasional layers of sand irregularly dispersed through it, the only recognizable band possessing a distinctive dark layer a few inches thick, but of wide distribution.

Along the banks of the rivers there occur extensive stretches of recent alluvium or alluvial clay. This consists of a mixture of sand and clay, and sometimes shows signs of stratification. A not uncommon form is an alteration of sand layers and clay lenticles, very similar in appearance to the commonest type of the Pegu beds.

Plate 24 is the Geological Map, covering all of the project area except the drainage basins of the water source streams.

c. Local Natural Conditions

(1) Meteorology

The upper part of the Yamethin District irrigation project area lies within the Dry Zone and the lower part of the area is in the Semi-dry Zone. The only temperature station within the project area is at Yamethin. The monthly range between maximum and minimum temperatures runs from a maximum range of 30·4° F. in February to a minimum range of 13·7° F. in August, with a mean monthly range of 20·9° F. Since evaporation is definitely influenced by the temperature range, the characteristics of the cycle indicate the rate of evaporation.

The normal relative humidity data at the Yamethin station cover the period from 1893 to 1940, with recordings at 9.00 and 18.00 hours BST. The maximum

TABLE

YAMETHIN DISTRICT

WATER SUPPLY AND

1	2	3	4	5	6	7	8	9	10
	Drainage Basin				*Reservoir Storage (acre feet)*				
Source	*Area (sq. mi.)*	*Average Annual Rain (inches)*	*Estimated Average Runoff (per cent)*	*Estimated Average Yield (acre feet)*	*Use Provision*	*Capacity*	*Evaporation Loss*	*Dead Storage*	*Net Available for Irrigation*
Thitson Chaung	119	32·6	30	62,100	Reservoir	66,000	6,000	—	56,100
Thitson Chaung	5	32·6	30	2,600	Diversion	1,600	1,000	—	1,600
Shweda Chaung	36	36·9	20	14,150	Reservoir & Diversion	13,500	5,000	—	9,150
Total				78,850	—	81,100	12,000	—	66,850
Myaungmadaw Canal	41	39·7	30	26,100	Kyeni Tank	18,500	7,500	—	18,600
Sinthe Chaung Upper	312	38·4	35	223,000	Reservoir	225,000	44,000	—	179,000
Lower	88	38·8	35	63,700	Reservoir	70,000	7,000	—	56,700
Total				312,800	—	313,500	58,500	—	254,300
Wells					Pumping				
Yezin Chaung	36	52·9	51	52,000	Reservoir	60,000	12,000	—	40,000
Total				52,000	—	60,000	12,000	—	40,000
Paunglaung River	1,741	50·4	50	2,340,000	Reservoir	280,000†			*
Subtotal									
					Pumping				‡
Subtotal									
Ngalaik Chaung	340	46·0	38	317,000	Reservoir	290,000	32,000	5,000	253,000
Total				317,000	—	290,000	32,000	5,000	253,000
Saing Chaung	145	68·0	40	210,000	Reservoir	240,000	25,000	100,000	115,000
Swa Chaung	421	71·3	40	638,000	Reservoir	400,000	40,000	50,000	310,000
Total				848 000	—	640,000	65,000	150,000	425,000

*Excess flow diverted through Supply Canal to Yezin Chaung

†Several dams are required for control of the total yield. Refer

‡Stream flow releases from reservoir. Present minimum flow

IX - 11

IRRIGATION PROJECT

USE DISTRIBUTION

11	12	13	14	15	16	17	18
	Land to be Served			Water Distribution (acre feet)			
Location: Refer to General Plan	Gross Acres	Net Acres Irrigated	Net Acres Second Crop	First Crop Supplement	Second Crop Total Irrigated	Total	Remarks
Teinnyetkon Canal	7,500	5,250	—	—	—	—	Yield may be diverted to existing tanks when in excess of storage facilities.
Thitson Canal	25,000	17,450	—	—	—	—	
	32,500	22,700	17,000	22,700	44,150	66,850	
Existing Canals North from Kyeni Tank	88,100	66,000	49,500	—	—	—	Yield may be diverted to existing tanks or for initial flooding when in excess of storage facilities.
Sinthe-N Canal Sinthe-S Canal	22,600	15,820	11,800	—	—	—	
	110,700	81,820	61,300	81,820	172,480	254,300	
	73,500	51,500	38,500	51,500	77,000	128,500	
Yezin High Level Canal	3,500	1,750	—	1,750	—	1,750	
Yezin District No. 1	17,280	15,550	7,600	15,550	22,800	38,350	
	20,780	17,300	7,600	17,300	22,800	40,100	
Yezin District No. 1	6,000	—	4,050	—	12,150	12,150	
Yezin District No. 2	9,240	7,400	5,550	7,400	16,650	24,050	
Yezin Canal	14,930	12,000	9,000	12,000	27,000	39,000	
Supply Canal	5,300	4,000	3,000	4,000	9,000	13,000	
	35,470	23,400	21,600	23,400	64,800	88,200	
P.1-N	3,840	2,880	2,160	2,880	6,480	9,360	Controlled flow from reservoir storage assures the pumping requirements. Pump operation is scheduled for 10-hour periods during peak power generation.
P.1-S	29,000	21,700	16,300	21,700	48,900	70,600	
P.2-N and S	18,500	13,000	9,750	13,000	29,250	42,250	
P.3-N	4,100	3,280	2,460	3,280	7,380	10,660	
P.3-S	16,800	13,450	10,000	13,450	30,000	43,450	
	72,240	54,310	40,670	54,310	122,010	176,320	
Ngalaik District No. 1	39,700	35,700	26,800	—	—	—	The excess yield will be used for passing of log rafts.
Ngalaik Canal	20,560	16,450	12,300	—	—	—	
Ngalaik District No. 2	18,100	12,700	9,500	—	—	—	
Ngalaik Canal	16,000	12,000	9,000	—	—	—	
	94,360	76,850	57,600	76,850	172,800	249,650	
Saing-N Canal	36,500	25,600	19,200	—	—	—	The excess yield will be used for passing of log rafts. Reservoirs are interconnected.
Swa-S Canal	133,400	107,000	81,000	—	—	—	
	169,900	132,600	100,200	132,600	300,600	433,200	

Reservoir and Distribution System.
to Hydroelectric Report for details of Hydro Development.
sufficient for P.1-N and S only.

relative humidity occurs at the 9.00 recording with a mean annual over the 48 years of 74% and the minimum relative humidity at the 18.00 recording with a mean annual over the 48 years of 66%. The minimum value of relative humidity occurs during March which implies that the maximum evaporation is during March. This agrees closely with the maximum temperature recorded during April.

Since moisture transpiration is dependent on air movement, precipitation and reservoir evaporation are affected by the wind. The maximum mean monthly wind speed recorded at Yamethin from 1931 to 1940 for an average of 24 hours was 6·2 miles per hour in July. The maximum wind speed for a shorter period is estimated to be about 12 miles per hour. The minimum mean monthly wind speed for the same period was 1·3 miles per hour in December. Since air movement affects transpiration of moisture it may be concluded that maximum precipitation occurs in August. The rainfall data of record suggest that the maximum occurs around August and September.

Reservoir storage is definitely affected by evaporation. Measured evaporation data are not available in Burma but with the natural weather conditions known, the amount was computed by the use of Meyer's formula. The computed evaporation for the year is 49·57 inches with a maximum in April of 8·15 inches and a minimum in December of 2·00 inches. This total evaporation agrees with the 48 inches suggested by various writers for reservoir evaporation in the Dry Zone of Burma and with actual measurements recorded in India.

(2) Hydrology

There is a definite lack of these data sufficient in detail, period length, and at proper location, to make correct evaluations and conclusions as required. The only rainfall data available for the project area are from rain-gauge stations entirely outside the drainage basins from which the project water originates. These data may not represent exact precipitation conditions within the drainage basins.

The cyclic variation in rainfall was determined by plotting progressive five-year means curves for each station from which peak rainfall and corresponding intervening periods were tabulated. These data suggest that the rainfall intensity in the drainage basins of the project could be classified under a seven-year cycle.

A map of the project area showing drainage basins, isohyetals, Theissen polygons, rain-gauge stations and a tabulation of the values for extreme maximum and minimum annual rainfall computed by the Theissen method and the mean annual rainfall computed by all three methods is shown on Plate 25. Records show that the maximum 24-hour 45-year rainfall at Yamethin is 5·6 inches and that the 24-hour 60-year rainfall at Toungoo is 6·55 inches.

Stream-flow records for the Yezin Chaung and Paunglaung River, for April 1952 to January 1953, computed from daily gauge readings and a rating curve prepared from stream-flow measurements at various gauge heights, are listed in Tables IX–12 and IX–13.

The flow data for both streams indicate very high yields from the drainage basins. The flow is excessive for the rainfall recorded at Pyinmana and one may immediately conclude that the rainfall in the mountain region of the drainage basin is much higher than the available records indicate. A study of the basin shapes, locations, and sizes verifies this as the possible reason for the high flow on the Paunglaung River, but the small size and location of the Yezin Chaung drainage basin does not justify the difference evidenced by the flow measurements. High sustained flows continue during the start of the dry months. These are no doubt from underground storage of previous rainfall but the over-all flow is still too large, suggesting the possibility of the supply coming from underground areas outside the stream drainage basin indicated by surface topography. Continuous stream-flow measurements and rainfall records from mountain stations over a period of years will establish the correct statistics.

It is impossible to establish accurate runoff factors from the information at hand because all the rain-gauge stations are in the valleys and thus reflect only valley rainfall; stream-flow data are only available on two streams and these for part of one year only; and storm periods are not recorded as such but are reflected only by 24-hour totals.

An examination of the flow (Tables IX–12 and IX–13), and a comparison with rain-gauge records at Pyinmana show that the rainfall is reflected by the flow at concurrent periods. One storm was chosen from the records and the hydrographs were prepared as shown on Plates 26 and 27. The runoff factors were computed for this storm and the time required for the water to flow from each drainage basin is also indicated on the plates. These runoff time periods suggest a basis for estimating peak flows with only drainage area and rainfall known and runoff factor assumed.

Flood flows of record are available on the drainage area for Meiktila Lake and Nyaungyan Tank, on the Thitson Chaung, and on the Zawgyi and Paunglaung Rivers. The first three named originate in and flow from the northern end of the Pegu Yomas. The last two originate in and flow from the Shan Hills. Methods used in determining the flows for the last three streams appear quite good. This information

TABLE IX – 12

YEZIN CHAUNG DRAINAGE BASIN
STREAM FLOW – 1952

(area 36 sq. mi.)

	Jan.–Feb.	*March*	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
Rainfall in inches*	0·34	2·24	—	1·74	6·41	12·40	11·48	10·83	8·51	0·74	—
1	Estimated Flow	Estimated Flow	13	10	27	27	125	400	178	521	65
2			13	10	19	22	311	335	178	203	65
3			10	10	36	36	79	338	386	203	50
4			10	10	32	32	547	401	178	178	50
5			10	10	47	27	321	306	178	156	50
6			10	10	51	36	238	298	184	133	50
7			10	10	36	101	190	238	221	106	50
8			10	10	57	36	178	197	371	106	50
9			10	10	13	36	178	830	932	184	50
10			10	10	13	62	278	447	454	141	50
11			10	10	13	36	246	277	226	133	50
12			10	10	13	41	178	209	322	186	50
13			10	10	13	41	296	220	299	133	50
14			10	10	13	65	657	218	304	133	50
15			10	10	13	61	432	178	206	106	50
16			10	10	19	50	321	191	203	106	50
17			10	23	21	36	298	184	231	106	50
18			10	10	15	27	253	256	203	106	36
19			10	10	28	66	487	178	197	106	36
20			10	13	22	41	415	1,330	366	106	36
21			10	26	15	36	362	840	358	106	36
22			10	18	13	306	253	640	239	80	36
23			10	18	13	161	178	506	238	80	36
24			10	47	13	159	163	354	215	80	36
25			10	13	13	163	456	197	230	80	36
26			10	13	18	178	695	425	197	80	36
27			10	13	13	178	467	423	242	65	36
28			10	13	105	185	535	169	231	65	36
29			10	26	75	299	321	197	281	65	36
30			10	46	204	326	1,054	178	197	65	36
31			—	21	—	209	443	—	212	—	36
Total†	1,100	350	306	470	983	3,079	10,955	10,958	8,394	3,918	1,384

*Annual Rainfall, Pyinmana (based on Pyinmana rainfall over the entire watershed) = 54·7 inches or 4·56 feet.

†Annual runoff, Yezin Chaung = 41,897 d.s.f.

Runoff factor = $\dfrac{41{,}897 \times 2}{36 \times 640 \times 4{\cdot}56} = 80\%$.

TABLE IX – 13

PAUNGLAUNG RIVER DRAINAGE BASIN
STREAM FLOW – 1952

(area 1,741 sq. mi.)

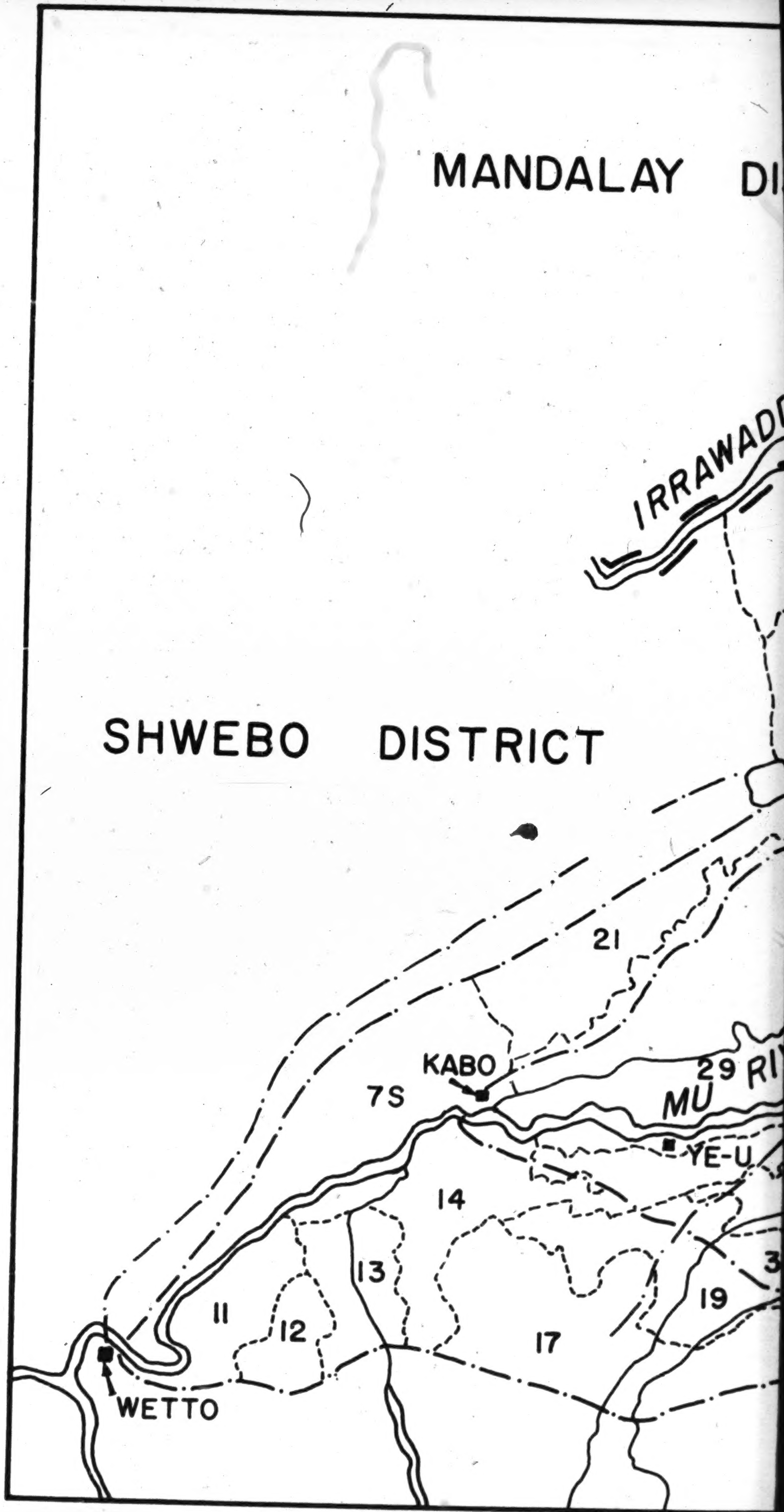
	Feb.–Mar.	*April*	*May*	*June*	*July*	*Aug.*	*Sept*	*Oct.*	*Nov.*	*Dec.*	*Jan.*
Rainfall in inches*	2·24	—	1·74	6·41	12·40	11·48	10·83	8·51	0·74	—	0·34
1	Estimated discharge 60 days at 2·0 = 120·0 d.s.f.	say 9 days 1·0 at 9·0 d.s.f.	1·0	3·4	6·3	18·2	20·1	14·0	10·5	4·7	Say 31 days at 3·0 = 93·0 d.s.f.
2			1·0	3·4	6·2	17·0	18·0	13·0	9·6	4·7	
3			1·0	3·8	7·0	16·4	13·2	13·2	8·9	4·5	
4			1·0	3·8	5·7	18·4	14·9	11·6	8·4	4·5	
5			0·7	4·4	5·8	19·1	14·0	10·5	8·0	4·5	
6			1·5	4·1	4·3	17·0	13·7	10·5	7·8	4·5	
7			2·0	2·9	4·8	14·6	12·8	10·5	7·6	4·4	
8			1·5	2·0	4·4	14·4	12·3	10·7	7·5	4·4	
9			1·0	2·0	4·3	13·9	19·1	13·2	7·6	4·3	
10		1·0	1·0	1·5	4·3	14·0	23·9	14·9	7·6	4·3	
11		1·0	0·7	1·5	5·3	14·6	21·0	13·7	7·5	4·1	
12		1·0	0·7	1·0	7·0	15·6	18·6	13·0	7·1	4·0	
13		1·0	1·0	1·0	6·8	14·4	17·2	13·3	7·0	4·0	
14		1·0	1·0	1·3	5·7	17·2	17·8	11·9	6·7	3·9	
15		1·0	0·7	2·0	5·8	19·1	16·6	10·4	6·5	3·9	2·8
16		1·0	0·7	2·0	6·5	17·4	15·1	11·9	6·5	3·9	
17		1·0	0·4	2·3	7·1	16·2	14·0	10·4	6·3	3·8	
18		1·0	0·4	1·5	7·6	15·1	12·8	10·1	6·2	3·8	
19		1·0	0·7	2·0	10·1	15·8	13·5	9·3	6·0	3·8	
20		1·0	1·5	1·8	13·0	15·3	19·0	9·3	5·9	3·6	
21		1·3	2·0	1·8	10·4	14·7	26·4	11·8	5·9	3·6	
22		1·3	4·8	1·5	10·1	14·0	25·0	11·2	5·7	3·6	
23		1·0	2·3	1·8	10·2	13·5	22·2	10·1	5·6	3·6	
24		1·0	1·5	2·0	11·4	13·7	19·7	9·4	5·4	3·6	
25		1·0	1·5	3·1	11·4	15·5	17·4	9·4	5·3	3·6	
26		1·0	1·8	4·3	11·4	17·2	22·4	9·1	5·1	3·6	
27		1·0	2·3	3·9	11·9	18·0	19·3	9·4	5·1	3·5	
28		0·7	2·6	4·8	17·6	17·2	18·0	8·9	5·0	3·5	
29		0·7	2·6	5·7	22·6	15·5	14·9	9·3	4·8	3·5	
30		0·7	2·8	6·5	22·2	21·4	13·9	10·7	4·8	3·5	
31		—	3·4	—	20·8	27·5†	—	11·8	—	3·4	2·9
Total‡	120·0	29·7	47·1	83·1	287·0	511·8	530·0	346·5	201·9	122·6	93·0

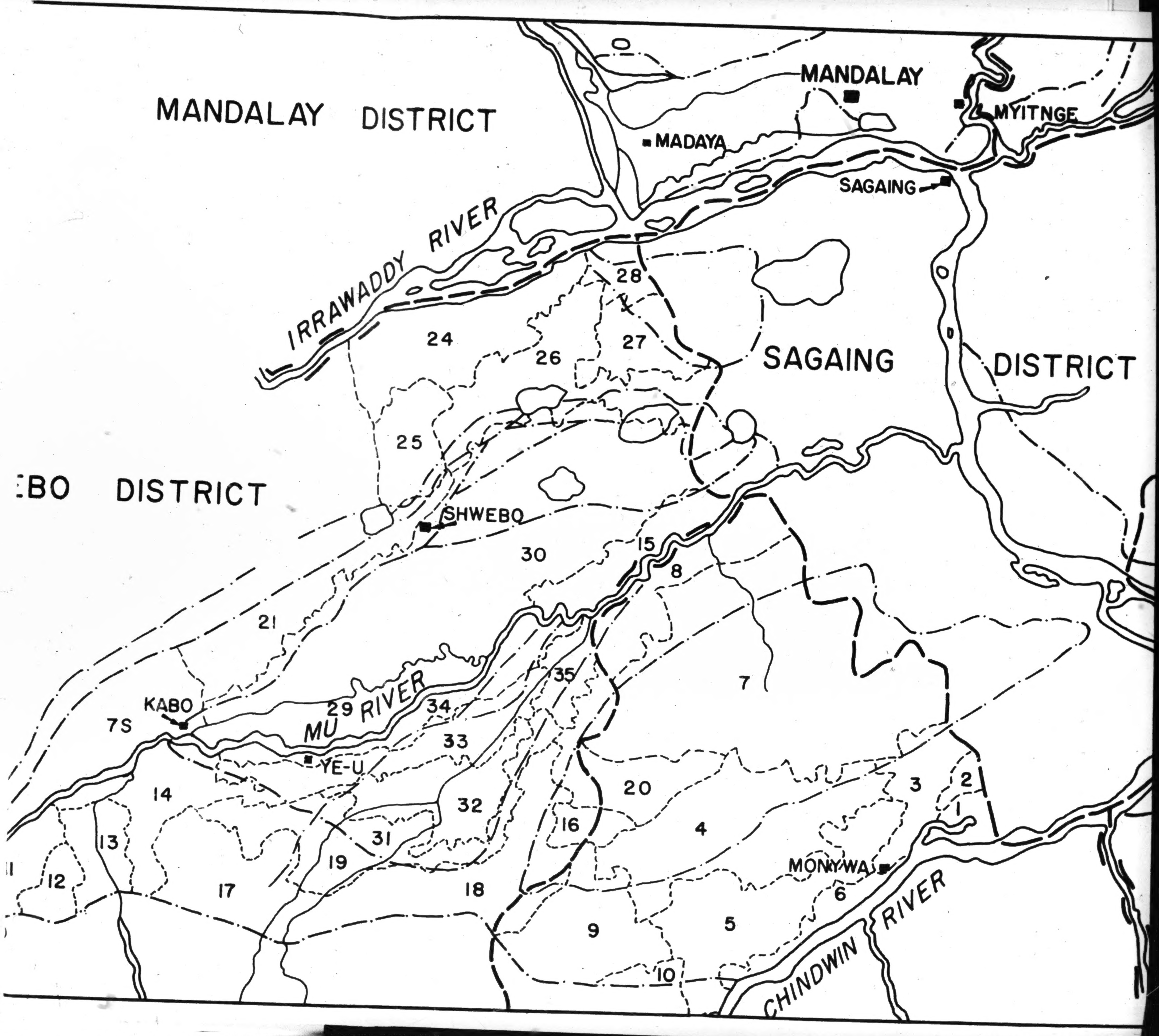
*Annual Rainfall, Pyinmana (based on Pyinmana rainfall over the entire watershed) = 54·7 inches or 4·56 feet.

†Estimated.

‡Annual runoff, Paunglaung River at dam site = 2,373·5 d.s.f. (runoff figures are in thousands).

Runoff factor $= \dfrac{2{,}373\cdot5 \times 1{,}000 \times 2}{4\cdot56 \times 640 \times 1{,}741} = 93\cdot4\%$.


MANDALAY DI
IRRAWADD
SHWEBO DISTRICT
21
KABO
7S
29
RI
MU
YE-U
14
13
11
12
17
19
3
WETTO


MANDALAY DISTRICT
MANDALAY
MYITNGE
MADAYA
SAGAING
IRRAWADDY RIVER
SAGAING DISTRICT
EBO DISTRICT
SHWEBO
KABO
YE-U
MU RIVER
MONYWA
CHINDWIN RIVER
28
27
24
26
25
30
15
8
21
7
35
29
34
7S
33
14
32
20
3
2
1
16
4
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31
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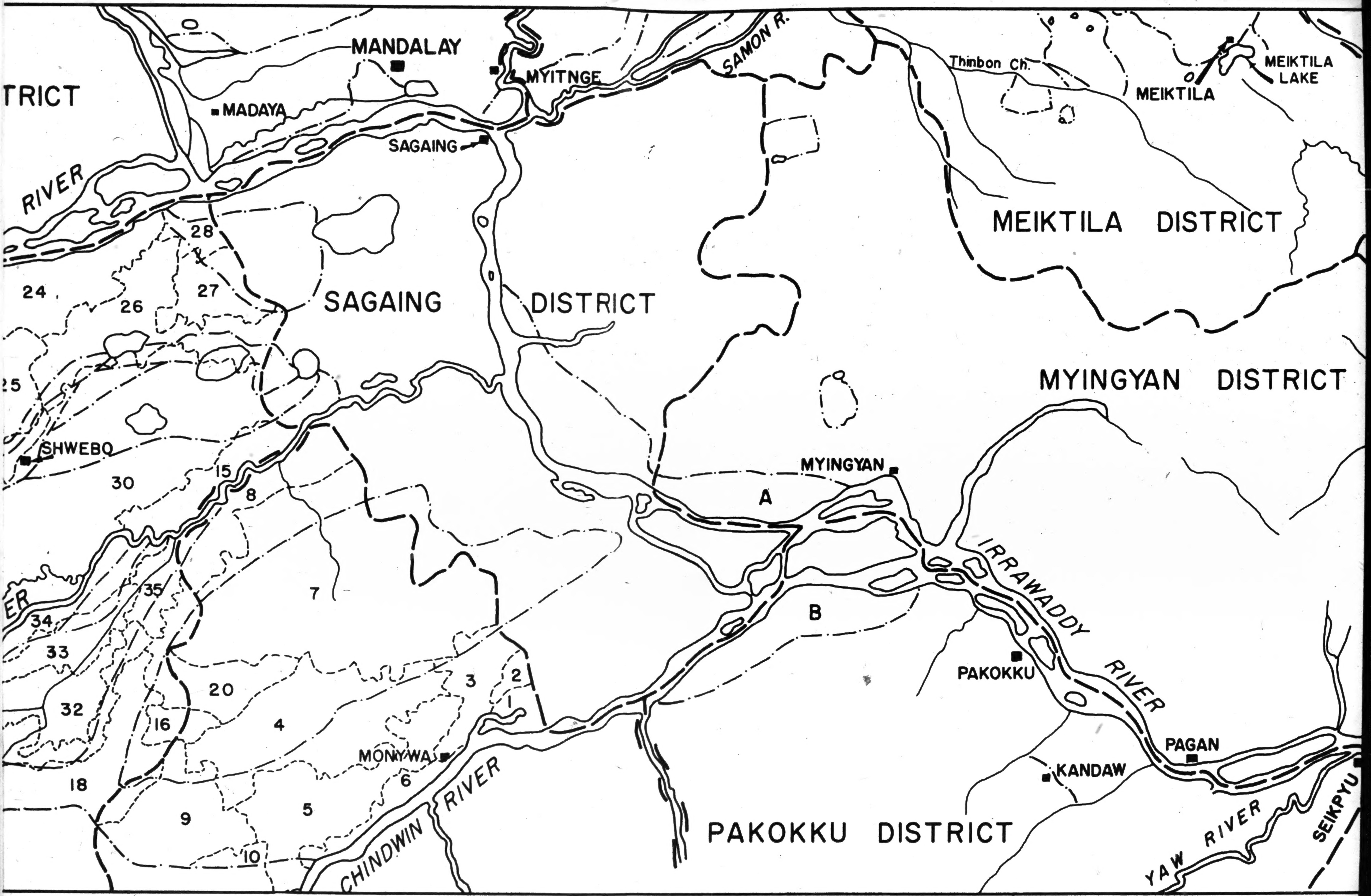
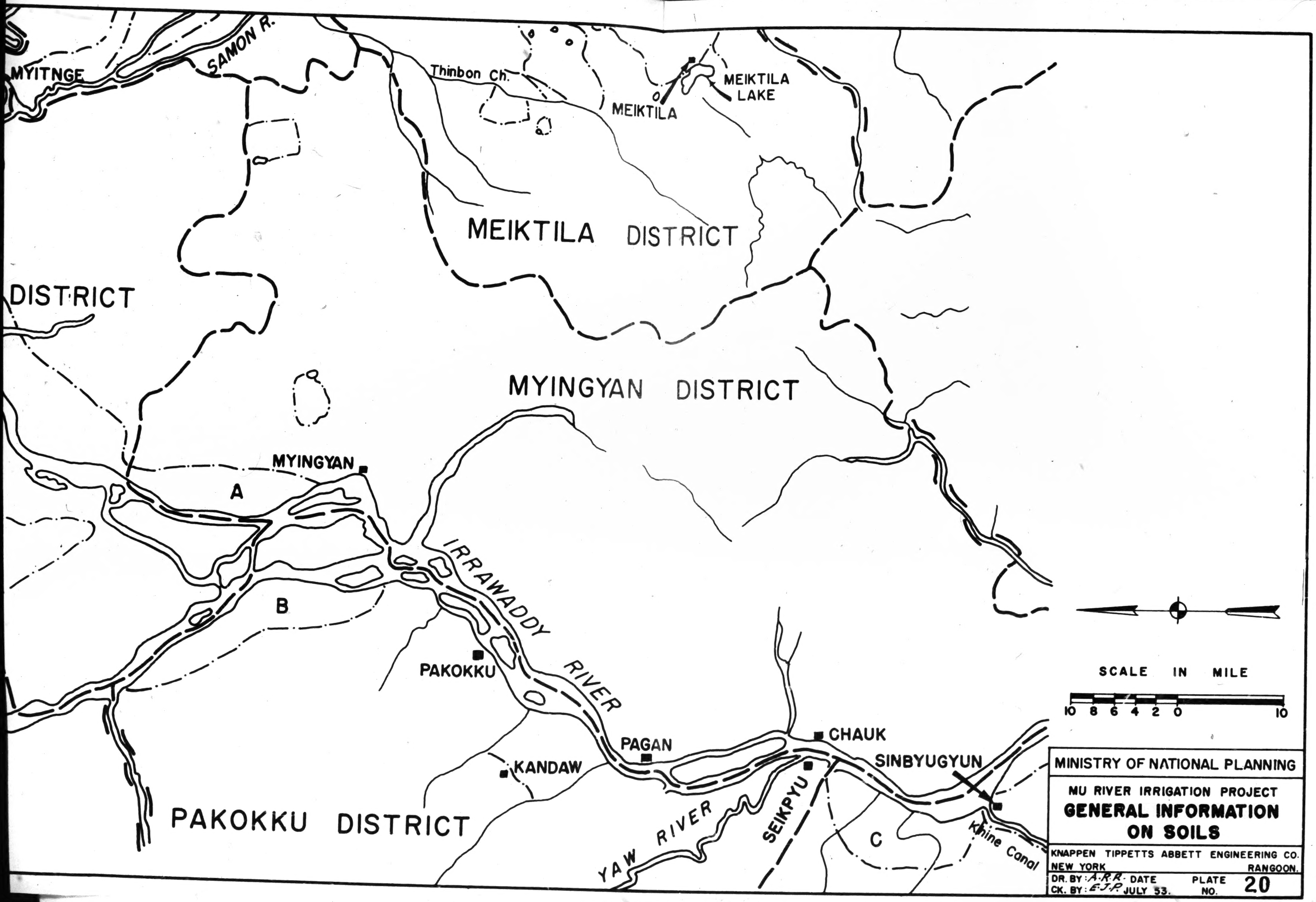
12
17
18
6
9
5
10



TRICT
MANDALAY
MYITNGE
SAMON R.
Thinbon Ch.
MEIKTILA
MEIKTILA LAKE
MADAYA
SAGAING
RIVER
MEIKTILA DISTRICT
SAGAING DISTRICT
MYINGYAN DISTRICT
28
27
24
26
25
SHWEBO
30
15
8
7
MYINGYAN
A
B
IRRAWADDY RIVER
ER
35
34
33
32
20
16
4
3
2
1
PAKOKKU
MONYWA
6
18
9
5
10
CHINDWIN RIVER
KANDAW
PAGAN
PAKOKKU DISTRICT
YAW RIVER
SEIKPYU


MYITNGE
SAMON R.
Thinbon Ch.
MEIKTILA
MEIKTILA LAKE
MEIKTILA DISTRICT
DISTRICT
MYINGYAN DISTRICT
MYINGYAN
A
B
C
IRRAWADDY RIVER
PAKOKKU
PAGAN
CHAUK
SINBYUGYUN
KANDAW
SEIKPYU
YAW RIVER
Khine Canal
PAKOKKU DISTRICT
SCALE IN MILE
10 8 6 4 2 0 10

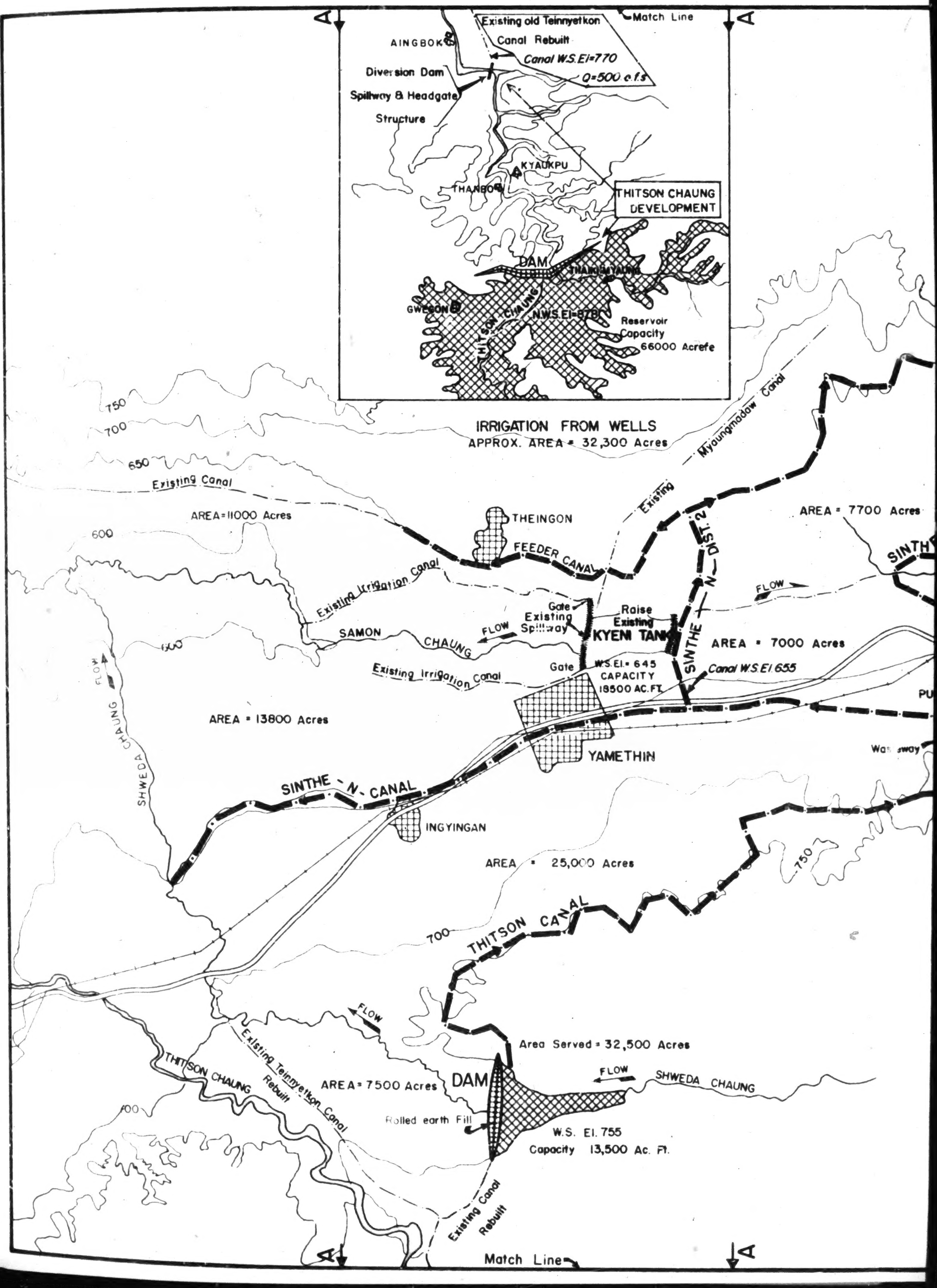
MINISTRY OF NATIONAL PLANNING

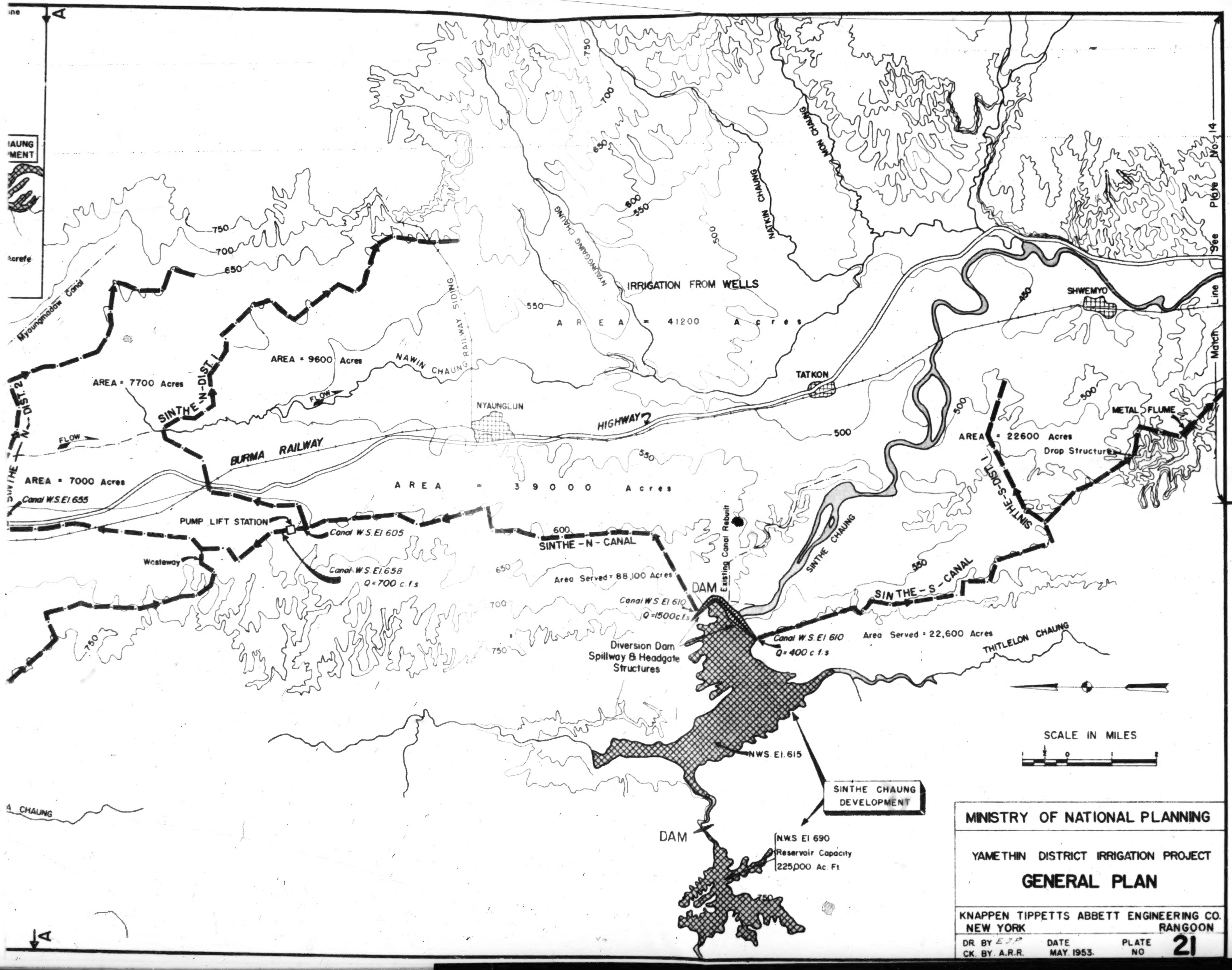
MU RIVER IRRIGATION PROJECT

GENERAL INFORMATION ON SOILS

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON.

DR. BY: A.R.R. DATE
CK. BY: E.J.P. JULY 53.
PLATE NO. 20


A
A
Match Line
Existing old Teinnyetkon
Canal Rebuilt
Canal W.S. El=770
Q=500 c.f.s
AINGBOK
Diversion Dam
Spillway & Headgate
Structure
KYAUKPU
THANBO
THITSON CHAUNG
DEVELOPMENT
DAM
THAIKBYAUNG
GWESON
THITSON CHAUNG
N.W.S. El=878
Reservoir
Capacity
66000 Acrefe
750
700
650
600
600
IRRIGATION FROM WELLS
APPROX. AREA = 32,300 Acres
Existing Myaungmadaw Canal
Existing Canal
AREA=11000 Acres
THEINGON
FEEDER CANAL
SINTHE - N - DIST. 2
AREA = 7700 Acres
SINTH
FLOW
Existing Irrigation Canal
Gate
Existing
Spillway
Raise
Existing
KYENI TANK
SAMON CHAUNG
FLOW
AREA = 7000 Acres
Gate
W.S. El = 645
CAPACITY
18500 AC. FT.
Existing Irrigation Canal
Canal W.S. El. 655
PU
FLOW
SHWEDA CHAUNG
AREA = 13800 Acres
YAMETHIN
Wasteway
SINTHE - N - CANAL
INGYINGAN
AREA = 25,000 Acres
750
THITSON CANAL
700
FLOW
Area Served = 32,500 Acres
FLOW
SHWEDA CHAUNG
Existing Teinnyetkon Canal
Rebuilt
THITSON CHAUNG
AREA = 7500 Acres
DAM
Rolled earth Fill
W.S. El. 755
Capacity 13,500 Ac. Ft.
700
Existing Canal
Rebuilt
Match Line
A
A


A
HAUNG
PMENT
Acrefe
Myaungmadaw Canal
750
700
650
600
550
500
450
350
SINTHE-N-DIST. 2
SINTHE-N-DIST. 1
FLOW
AREA = 7700 Acres
AREA = 9600 Acres
AREA = 7000 Acres
Canal W.S. El 655
NAWIN CHAUNG
NYAUNGLUN RAILWAY SIDING
NYAUNGLUN
NYAUNGGAING CHAUNG
NATKIN CHAUNG
MON CHAUNG
IRRIGATION FROM WELLS
AREA = 41200 Acres
TATKON
SHWEMYO
HIGHWAY
BURMA RAILWAY
AREA = 39000 Acres
PUMP LIFT STATION
Canal W.S. El 605
Canal W.S. El 658
Q=700 c.f.s
Wasteway
SINTHE-N-CANAL
Area Served = 88,100 Acres
Existing Canal Rebuilt
DAM
Canal W.S El 610
Q=1500 c.f.s
Diversion Dam Spillway & Headgate Structures
SINTHE CHAUNG
SINTHE-S-CANAL
Canal W.S. El 610
Q=400 c.f.s
Area Served = 22,600 Acres
THITLELON CHAUNG
AREA = 22600 Acres
SINTHE-S-DIST. 1
METAL FLUME
Drop Structures
See Plate No. 14
Match Line
N.W.S. El. 615
SINTHE CHAUNG DEVELOPMENT
DAM
N.W.S. El 690
Reservoir Capacity 225,000 Ac. Ft.
A CHAUNG
SCALE IN MILES
1 0 1 2

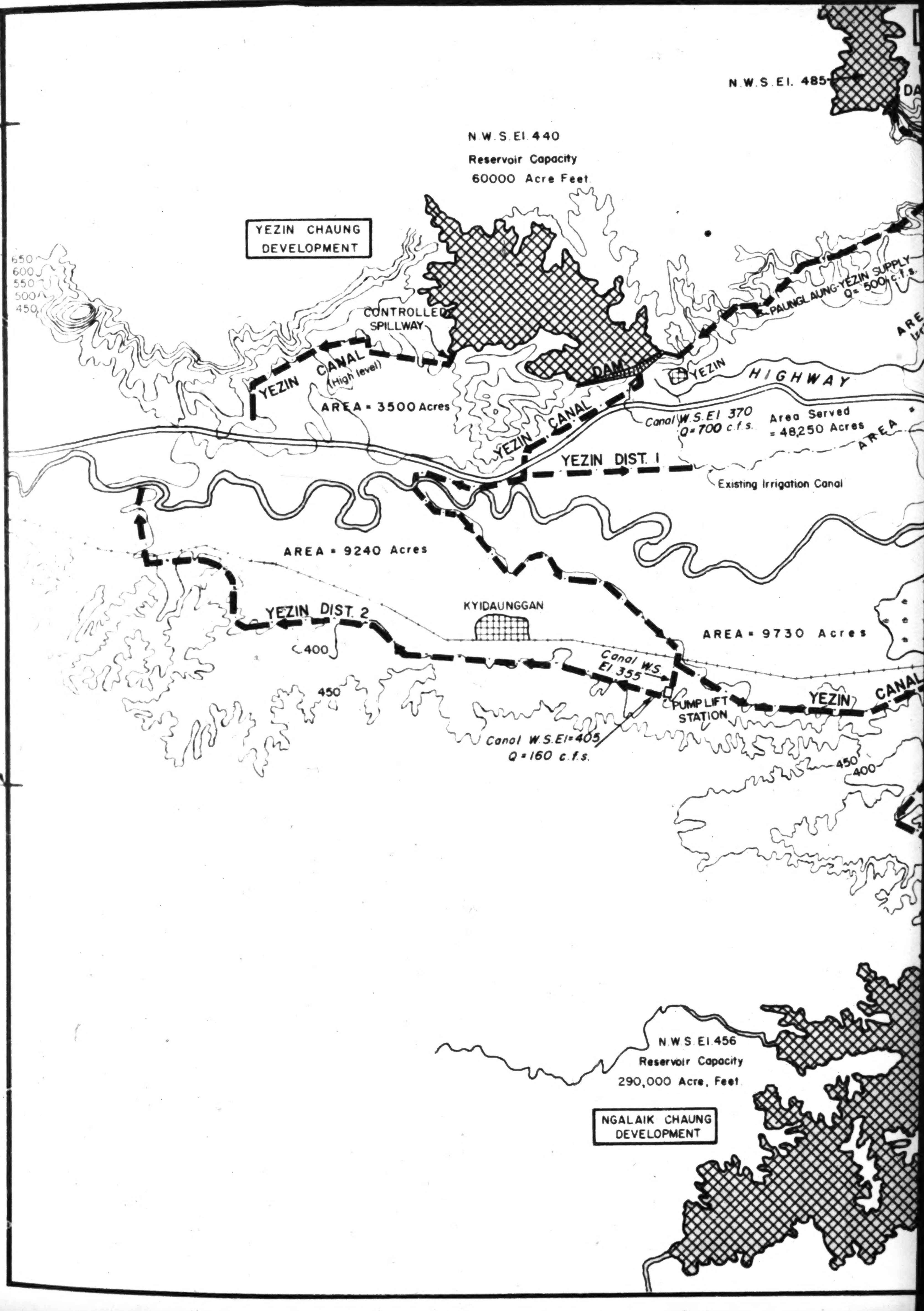
MINISTRY OF NATIONAL PLANNING

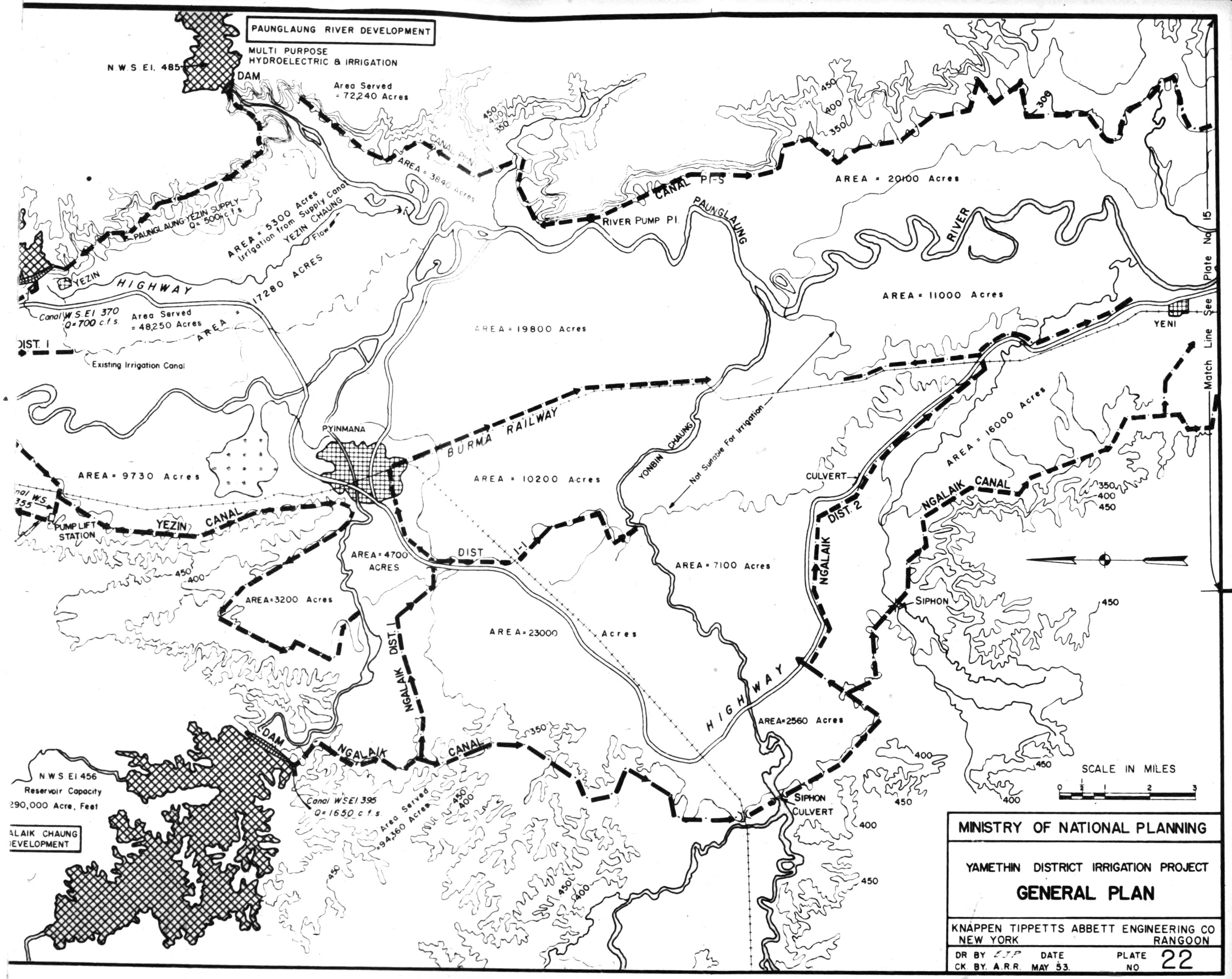
YAMETHIN DISTRICT IRRIGATION PROJECT

GENERAL PLAN

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P. DATE PLATE
CK. BY A.R.R. MAY. 1953. NO 21


N.W.S. El. 485
N.W.S. El. 440
Reservoir Capacity
60000 Acre Feet.
YEZIN CHAUNG
DEVELOPMENT
650
600
550
500
450
Match Line See Plate No 13
CONTROLLED
SPILLWAY
YEZIN CANAL
(High level)
AREA = 3500 Acres
DAM
YEZIN
HIGHWAY
PAUNGLAUNG-YEZIN SUPPLY
Q= 500 c.f.s.
YEZIN CANAL
Canal W.S. El 370
Q=700 c.f.s.
Area Served
= 48,250 Acres
AREA
YEZIN DIST. 1
Existing Irrigation Canal
AREA = 9240 Acres
KYIDAUNGGAN
YEZIN DIST. 2
400
450
AREA = 9730 Acres
Canal W.S.
El 355
PUMP LIFT
STATION
YEZIN CANAL
Canal W.S. El=405
Q=160 c.f.s.
450
400
N.W.S. El.456
Reservoir Capacity
290,000 Acre, Feet.
NGALAIK CHAUNG
DEVELOPMENT


PAUNGLAUNG RIVER DEVELOPMENT
MULTI PURPOSE
HYDROELECTRIC & IRRIGATION
N.W.S. El. 485
DAM
Area Served
= 72,240 Acres
450
400
350
CANAL P1-N
AREA = 3840 Acres
PAUNGLAUNG-YEZIN SUPPLY
Q = 500 c.f.s.
AREA = 5300 Acres
Irrigation from Supply Canal
YEZIN CHAUNG
Flow
YEZIN
HIGHWAY
17280 ACRES
AREA
Canal W.S. El 370
Q = 700 c.f.s.
Area Served
= 48,250 Acres
DIST. I
Existing Irrigation Canal
CANAL P1-S
River Pump P1.
PAUNGLAUNG
RIVER
AREA = 20100 Acres
300
AREA = 19800 Acres
AREA = 11000 Acres
YENI
See Plate No. 15
Match Line
PYINMANA
BURMA RAILWAY
AREA = 9730 Acres
Canal W.S. 355
PUMP LIFT STATION
YEZIN CANAL
AREA = 10200 Acres
YONBIN CHAUNG
Not Suitable For Irrigation
AREA = 16000 Acres
CULVERT
NGALAIK CANAL
NGALAIK DIST. 2
350
400
450
DIST. I-1
AREA = 4700 ACRES
AREA = 7100 Acres
AREA = 3200 Acres
SIPHON
AREA = 23000 Acres
NGALAIK DIST. I
HIGHWAY
AREA = 2560 Acres
DAM
NGALAIK CANAL
N.W.S. El. 456
Reservoir Capacity
290,000 Acre. Feet
ALAIK CHAUNG
DEVELOPMENT
Canal W.S.El. 395
Q = 1650 c.f.s.
Area Served
= 94,360 Acres
SIPHON
CULVERT
SCALE IN MILES
0 ½ 1 2 3

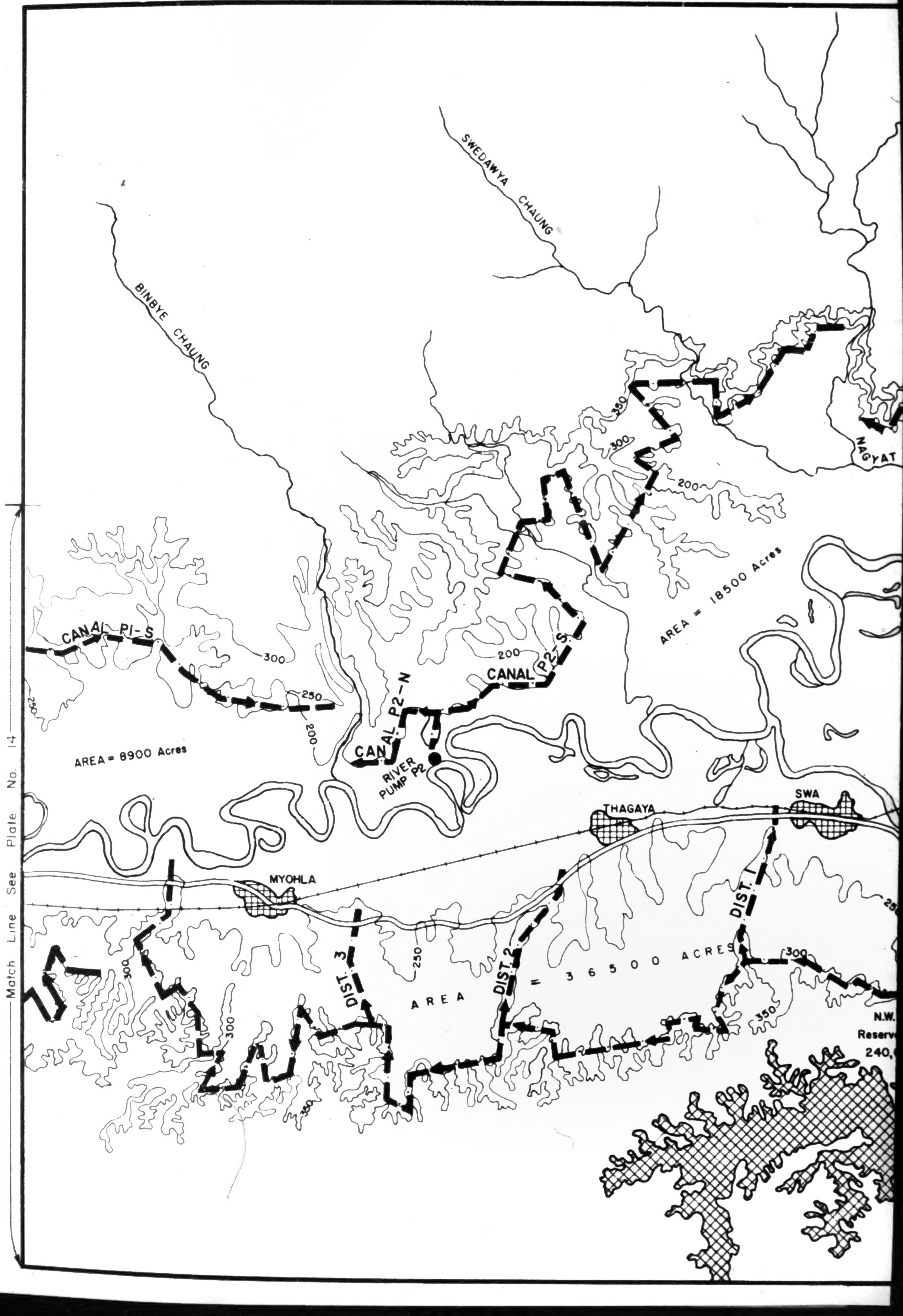
MINISTRY OF NATIONAL PLANNING

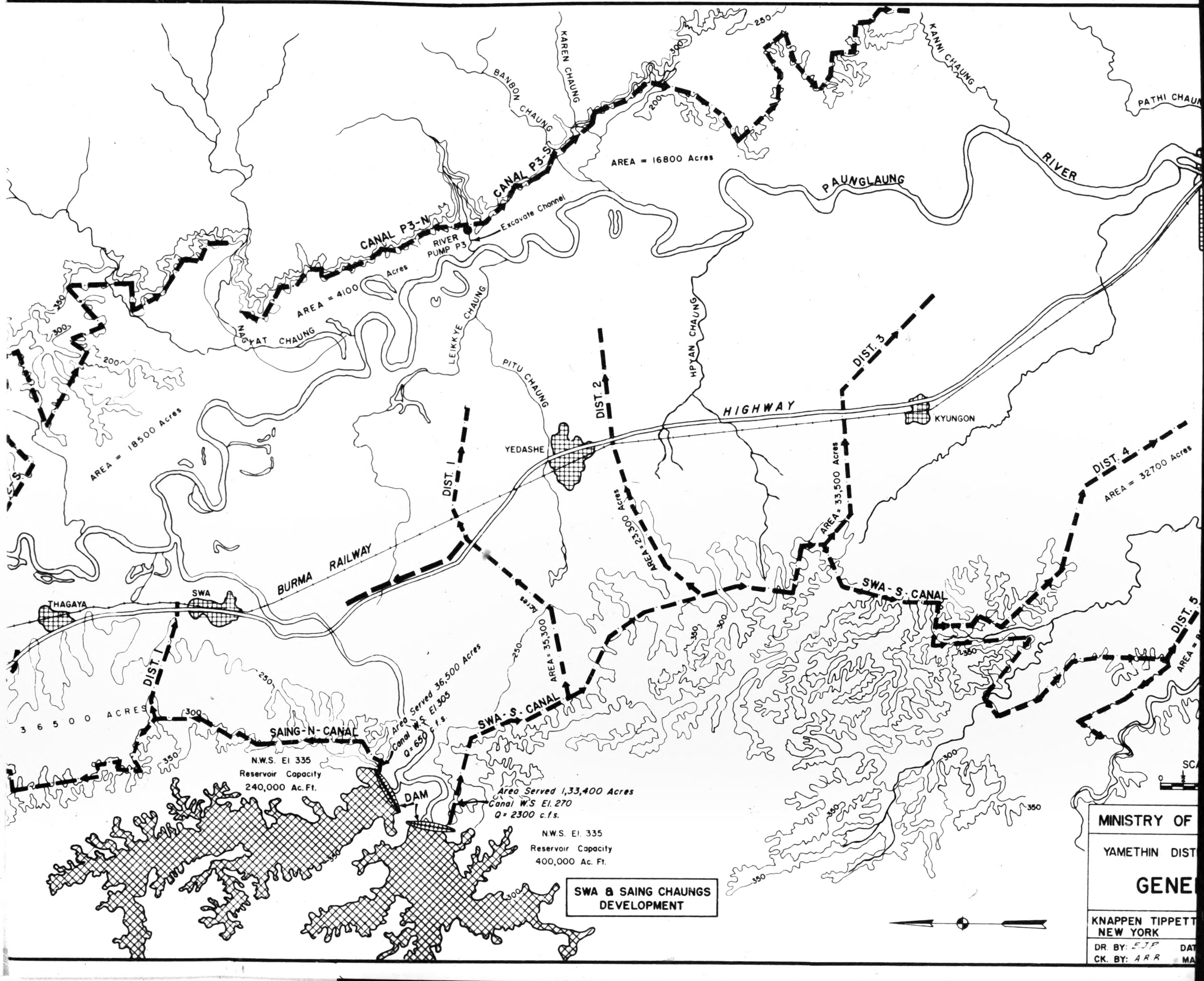
YAMETHIN DISTRICT IRRIGATION PROJECT

GENERAL PLAN

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON

DR BY E.T.P. DATE PLATE
CK. BY. A.R.R. MAY 53. NO 22


SWEDAWYA CHAUNG
BINBYE CHAUNG
350
300
200
NAGYAT
AREA = 18500 Acres
CANAL P1-S
300
250
250
200
AREA = 8900 Acres
CANAL P2-S
CANAL P2-N
RIVER PUMP P2
THAGAYA
SWA
MYOHLA
250
DIST. 1
DIST. 2
DIST. 3
AREA = 36500 ACRES
300
300
350
300
350
250
N.W.
Reserv
240,
Match Line See Plate No. 14


SWA & SAING CHAUNGS DEVELOPMENT
KAREN CHAUNG
BANBON CHAUNG
KANNI CHAUNG
PATHI CHAUN
RIVER
PAUNGLAUNG
CANAL P3-S
CANAL P3-N
RIVER PUMP P3
Excavate Channel
AREA = 16800 Acres
AREA = 4100 Acres
NAGYAT CHAUNG
LEIKKYE CHAUNG
PITU CHAUNG
HPYAN CHAUNG
AREA = 18500 Acres
DIST. 1
DIST. 2
DIST. 3
DIST. 4
DIST. 5
HIGHWAY
KYUNGON
YEDASHE
BURMA RAILWAY
THAGAYA
SWA
AREA = 33,500 Acres
AREA = 32700 Acres
AREA = 23,300 Acres
AREA = 35,300 Acres
SWA-S-CANAL
SAING-N-CANAL
3 6 5 0 0 ACRES
Area Served 36,500 Acres
Canal W.S. El. 305
Q = 650 c.f.s.
N.W.S. El 335
Reservoir Capacity
240,000 Ac. Ft.
DAM
Area Served 1,33,400 Acres
Canal W.S El. 270
Q = 2300 c.f.s.
N.W.S. El. 335
Reservoir Capacity
400,000 Ac. Ft.
200
250
300
350
SCA
0

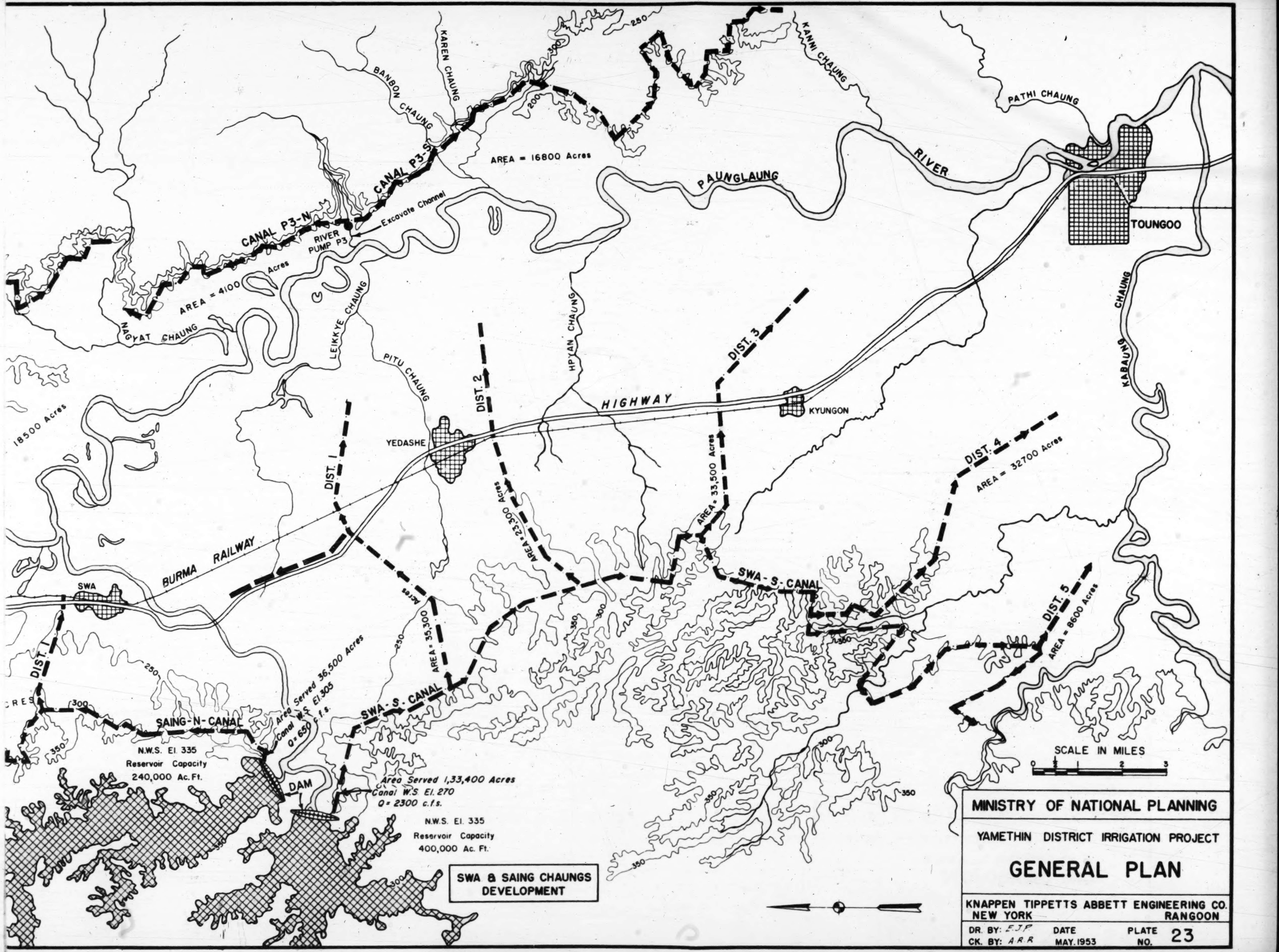
MINISTRY OF

YAMETHIN DIST

GENE

KNAPPEN TIPPETT
NEW YORK

DR. BY: E.J.P. DAT
CK. BY: A.R.R. MA


CANAL P3-N
CANAL P3-S
BANBON CHAUNG
KAREN CHAUNG
KANNI CHAUNG
PATHI CHAUNG
AREA = 16800 Acres
PAUNGLAUNG
RIVER
TOUNGOO
Excavate Channel
RIVER PUMP P3
AREA = 4100 Acres
NAGYAT CHAUNG
LEIKKYE CHAUNG
PITU CHAUNG
HPYAN CHAUNG
KABAUNG CHAUNG
DIST. 1
DIST. 2
DIST. 3
DIST. 4
DIST. 5
HIGHWAY
KYUNGON
YEDASHE
18500 Acres
AREA = 23,300 Acres
AREA = 33,500 Acres
AREA = 32700 Acres
AREA = 8600 Acres
AREA = 35,300 Acres
BURMA RAILWAY
SWA
SWA - S - CANAL
SAING - N - CANAL
CRES
Area Served 36,500 Acres
Canal W.S. El. 305
Q = 650 c.f.s.
N.W.S. El. 335
Reservoir Capacity
240,000 Ac. Ft.
DAM
Area Served 1,33,400 Acres
Canal W.S. El. 270
Q = 2300 c.f.s.
N.W.S. El. 335
Reservoir Capacity
400,000 Ac. Ft.
SWA & SAING CHAUNGS DEVELOPMENT
200
250
300
350
SCALE IN MILES
0
1/2
1
2
3

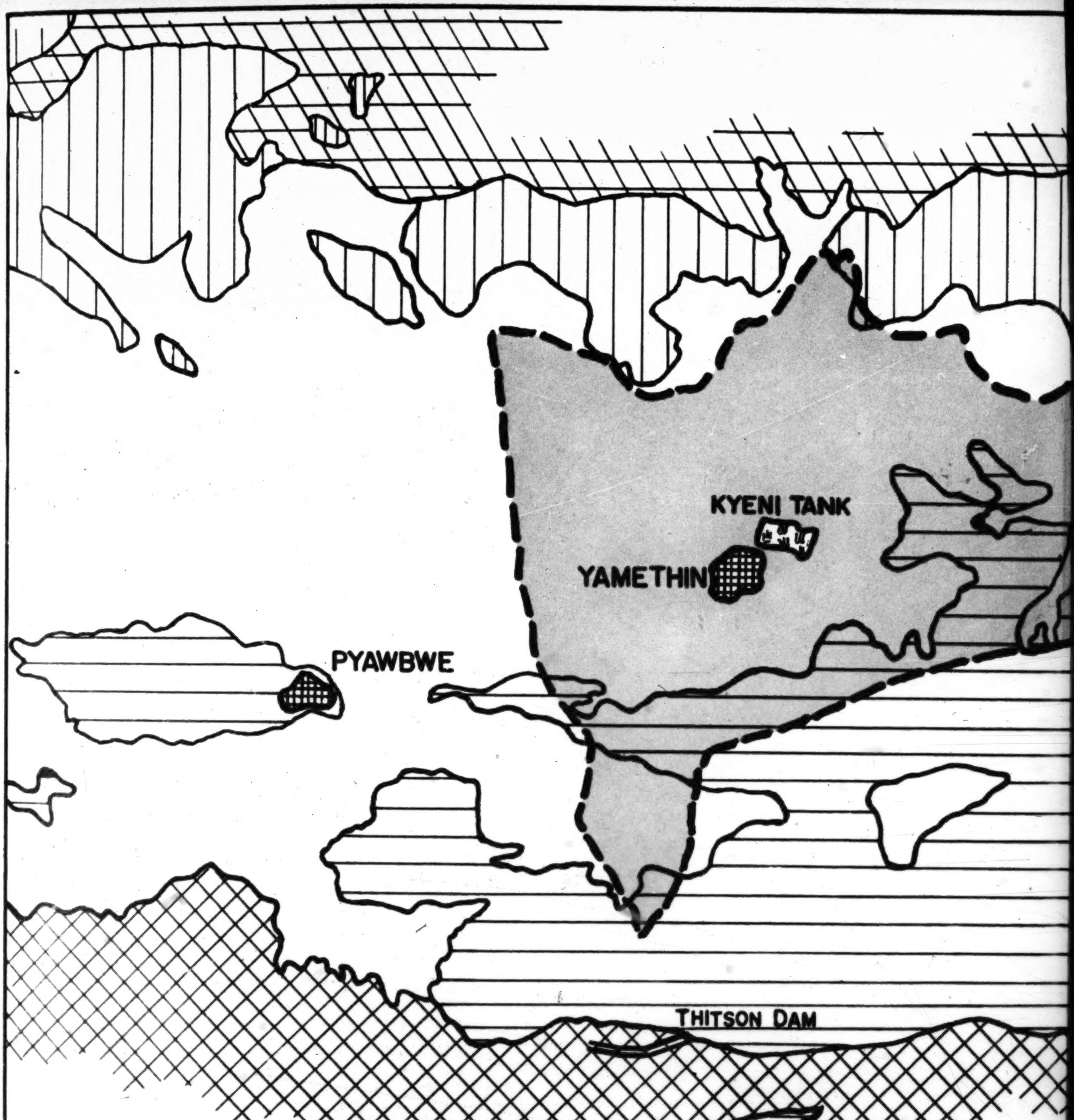
MINISTRY OF NATIONAL PLANNING

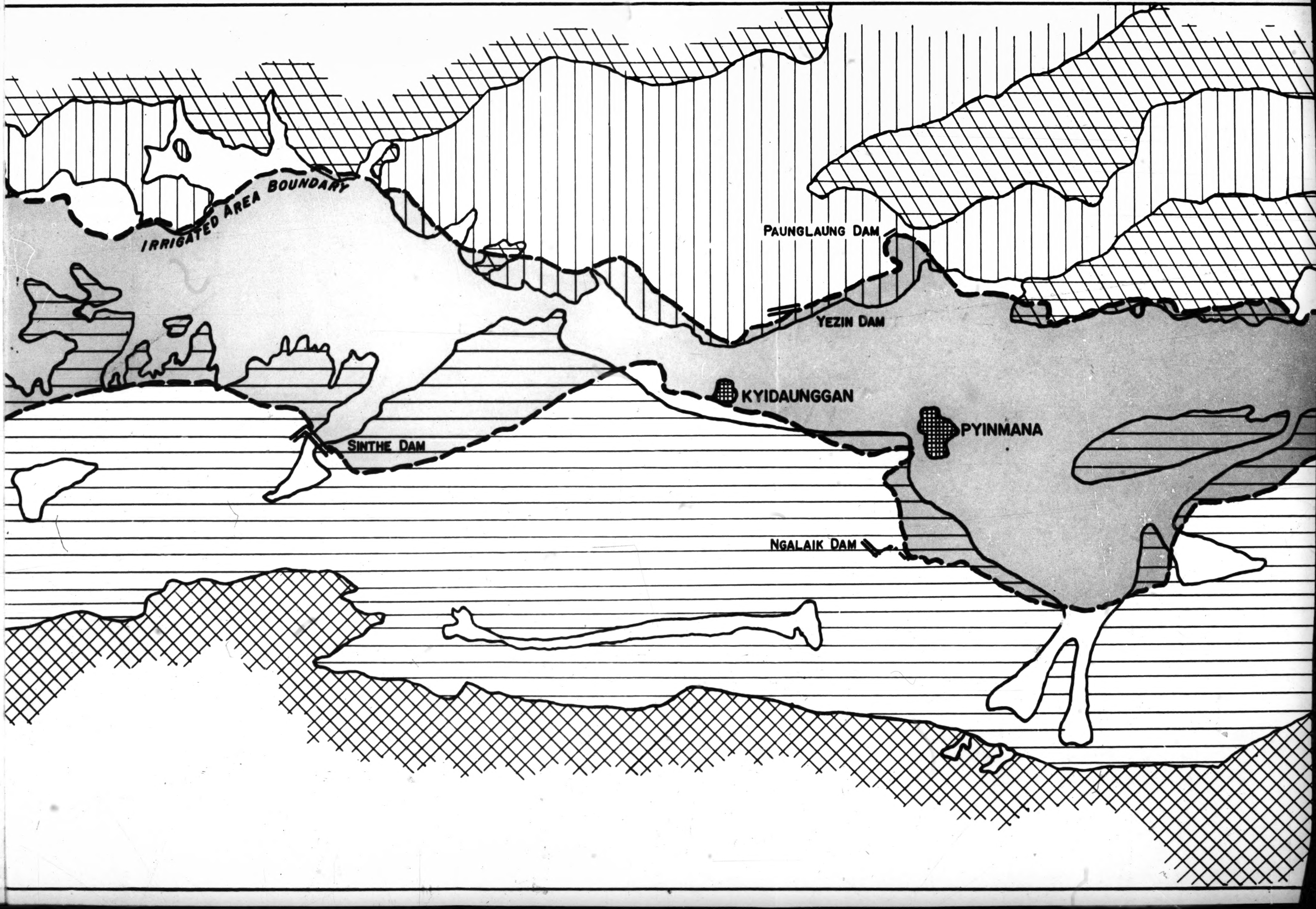
YAMETHIN DISTRICT IRRIGATION PROJECT

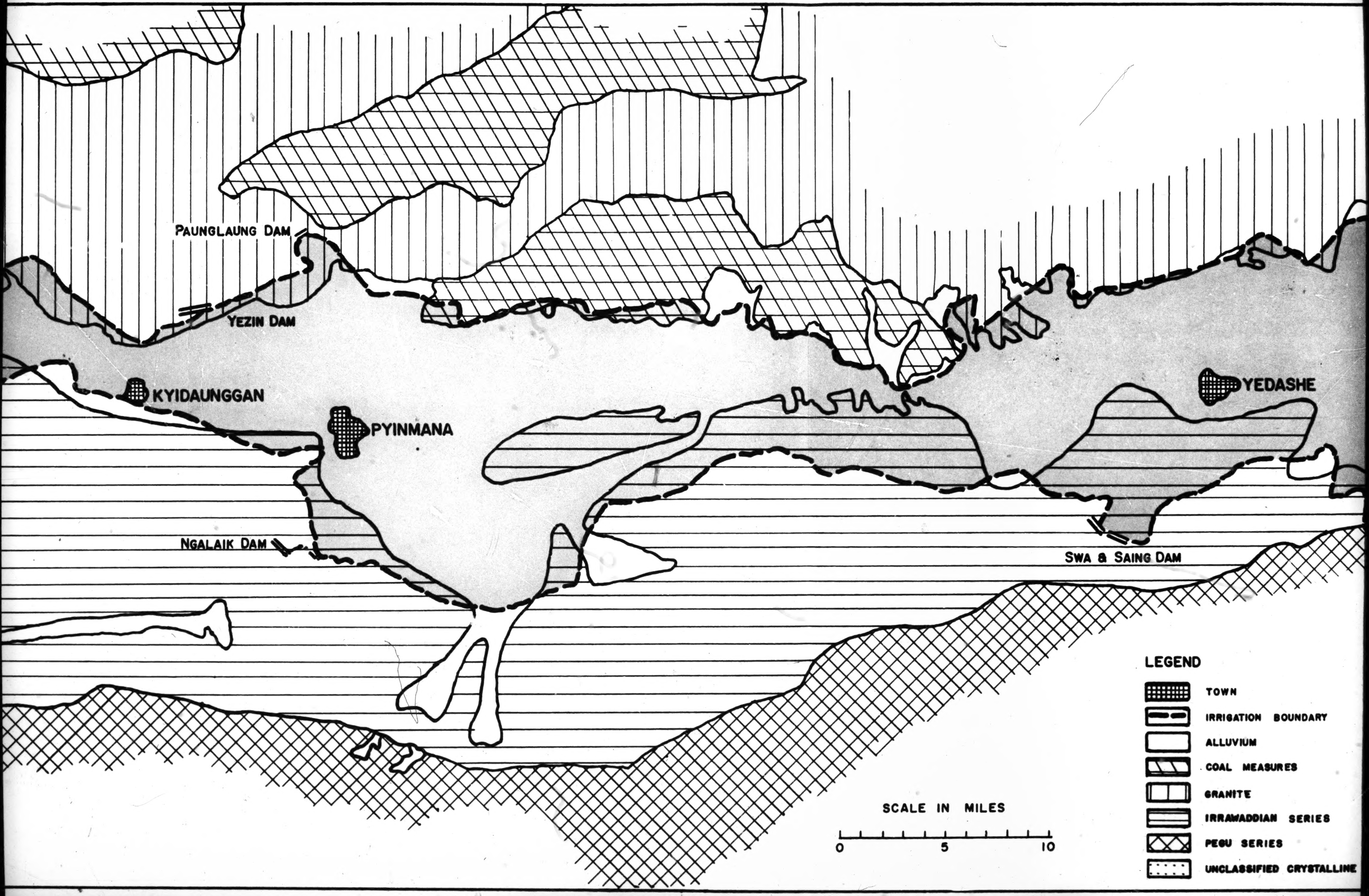
GENERAL PLAN

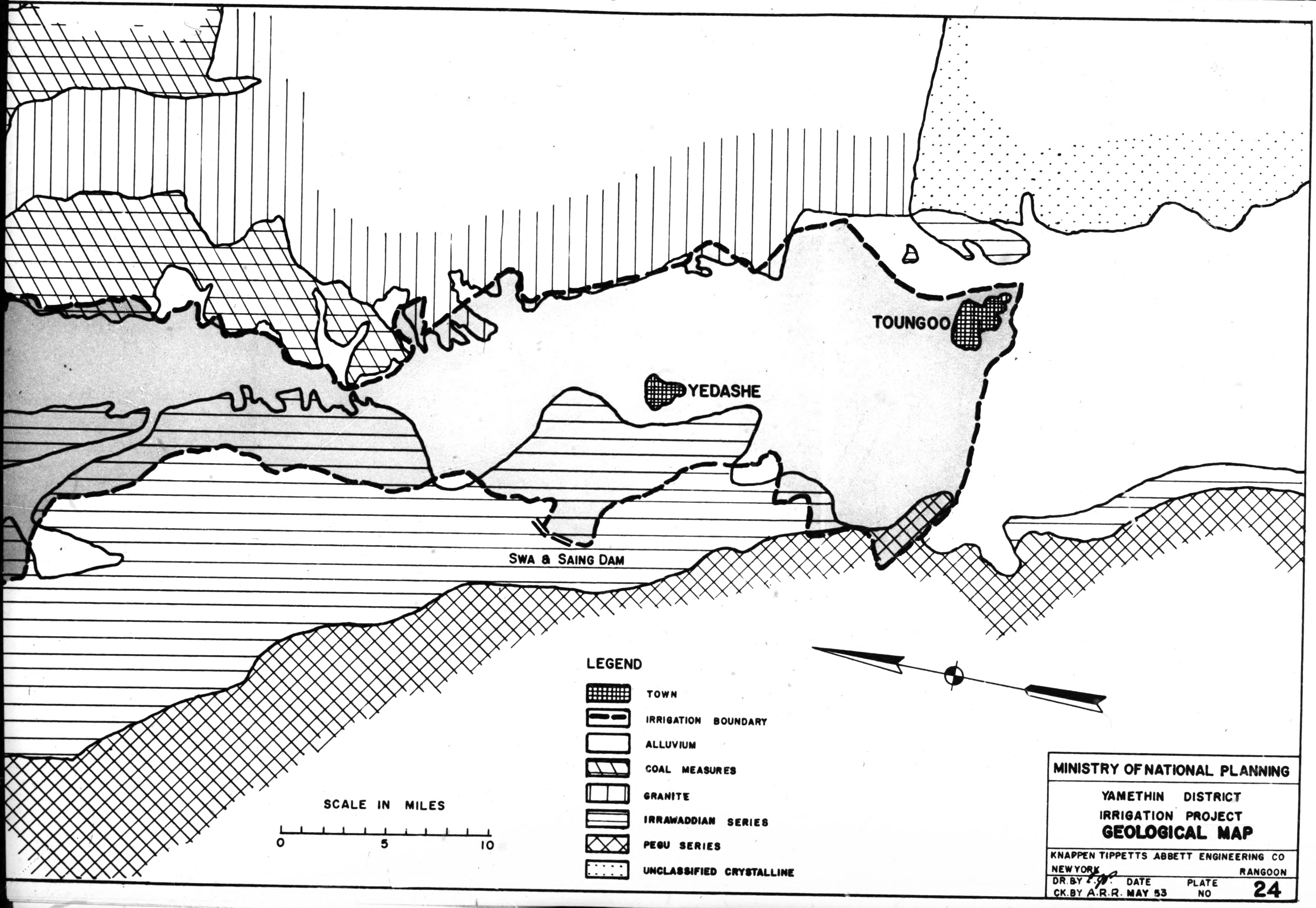
KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY: E.J.P. DATE PLATE NO. 23
CK. BY: A.R.R. MAY. 1953


KYENI TANK
YAMETHIN
PYAWBWE
THITSON DAM


IRRIGATED AREA BOUNDARY
PAUNGLAUNG DAM
YEZIN DAM
KYIDAUNGGAN
PYINMANA
SINTHE DAM
NGALAIK DAM


PAUNGLAUNG DAM
YEZIN DAM
KYIDAUNGGAN
PYINMANA
YEDASHE
NGALAIK DAM
SWA & SAING DAM
LEGEND
TOWN
IRRIGATION BOUNDARY
ALLUVIUM
COAL MEASURES
GRANITE
IRRAWADDIAN SERIES
PEGU SERIES
UNCLASSIFIED CRYSTALLINE
SCALE IN MILES
0
5
10

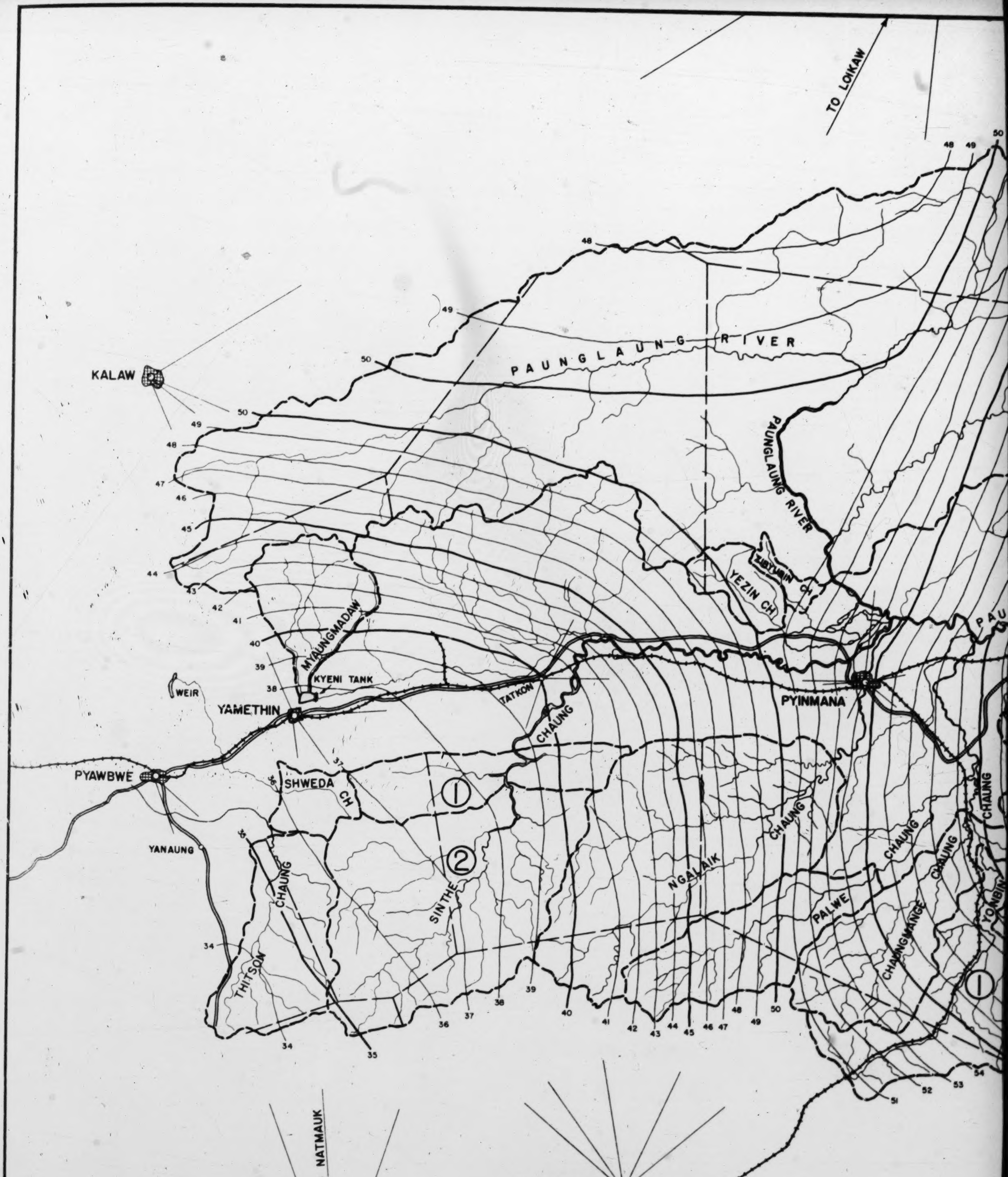

TOUNGOO
YEDASHE
SWA & SAING DAM
LEGEND
▦ TOWN
IRRIGATION BOUNDARY
ALLUVIUM
COAL MEASURES
GRANITE
IRRAWADDIAN SERIES
PEGU SERIES
UNCLASSIFIED CRYSTALLINE
SCALE IN MILES
0
5
10

MINISTRY OF NATIONAL PLANNING

YAMETHIN DISTRICT
IRRIGATION PROJECT
GEOLOGICAL MAP

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON

DR. BY DATE PLATE NO **24**
CK. BY A.R.R. MAY 53


TO LOIKAW
KALAW
PAUNGLAUNG RIVER
PAUNGLAUNG RIVER
ZIBYUBIN CH
YEZIN CH
MYAUNGMADAW
KYENI TANK
WEIR
YAMETHIN
TATKON
CHAUNG
PYINMANA
PAU
PYAWBWE
SHWEDA CH
YANAUNG
①
②
THITSON
CHAUNG
SINTHE
NGALAIK
CHAUNG
PALWE
CHAUNG
CHAUNGMANGE
CHAUNG
CHAUNG
YONBIN
CHAUNG
①
TO NATMAUK
TAUNGDWINGYI
34
35
36
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41
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43
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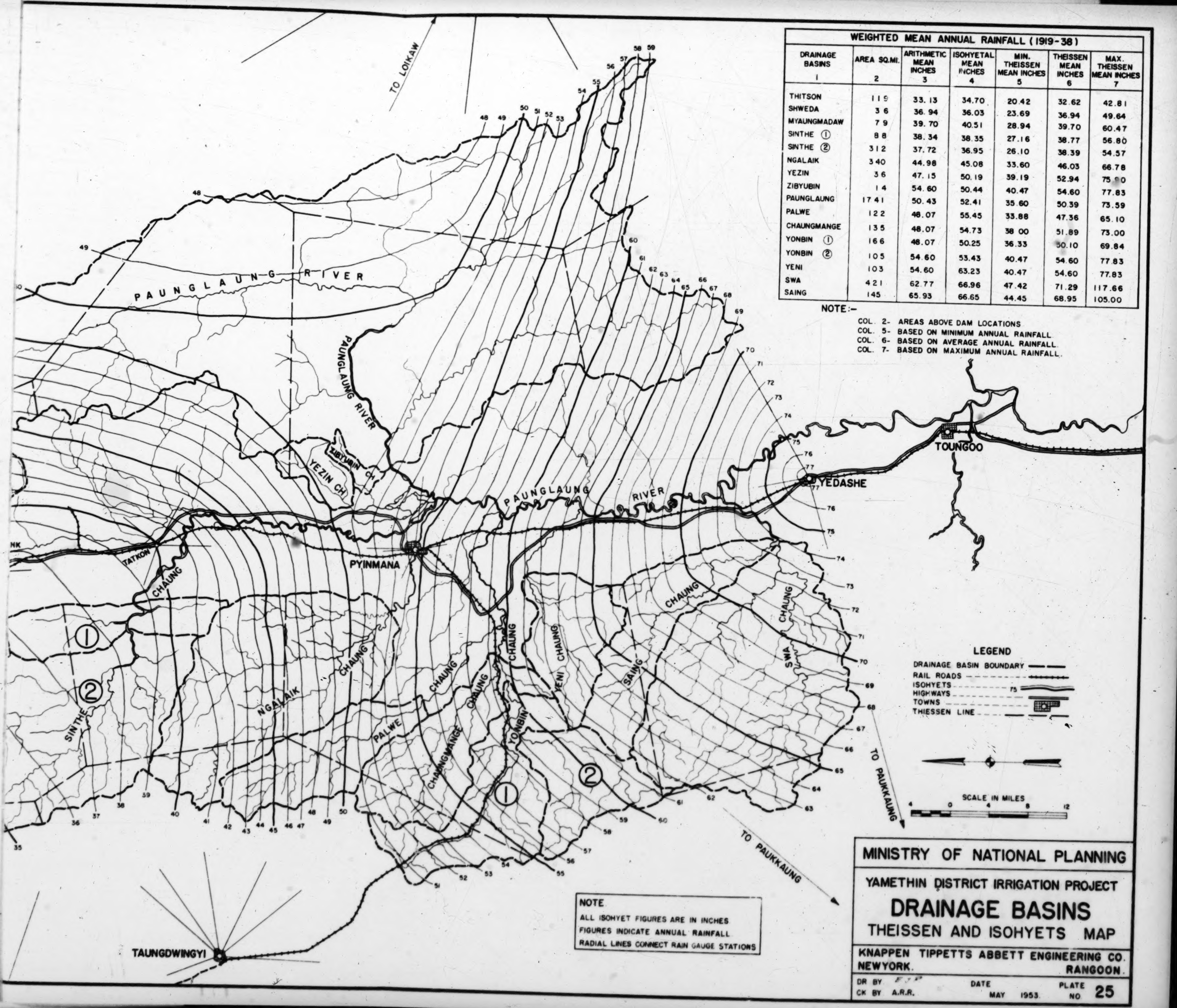
49
50
51
52
53
54


TO LOIKAW
PAUNGLAUNG RIVER
PAUNGLAUNG RIVER
ZIBYUBIN CH
YEZIN CH
PAUNGLAUNG RIVER
TOUNGOO
YEDASHE
PYINMANA
TATKON
CHAUNG
SINTHE
①
②
NGALAIK
CHAUNG
PALWE
CHAUNG
CHAUNGMANGE
CHAUNG
YONBIN
CHAUNG
YENI
CHAUNG
SAING
CHAUNG
SWA
CHAUNG
①
②
TO PAUKKAUNG
TO PAUKKAUNG
TAUNGDWINGYI
LEGEND
DRAINAGE BASIN BOUNDARY
RAIL ROADS
ISOHYETS 75
HIGHWAYS
TOWNS
THEISSEN LINE
SCALE IN MILES
4 0 4 8 12

NOTE
ALL ISOHYET FIGURES ARE IN INCHES
FIGURES INDICATE ANNUAL RAINFALL
RADIAL LINES CONNECT RAIN GAUGE STATIONS

WEIGHTED MEAN ANNUAL RAINFALL (1919-38)

DRAINAGE BASINS 1	AREA SQ.MI. 2	ARITHMETIC MEAN INCHES 3	ISOHYETAL MEAN INCHES 4	MIN. THEISSEN MEAN INCHES 5	THEISSEN MEAN INCHES 6	MAX. THEISSEN MEAN INCHES 7
THITSON	119	33.13	34.70	20.42	32.62	42.81
SHWEDA	36	36.94	36.03	23.69	36.94	49.64
MYAUNGMADAW	79	39.70	40.51	28.94	39.70	60.47
SINTHE ①	88	38.34	38.35	27.16	38.77	56.80
SINTHE ②	312	37.72	36.95	26.10	38.39	54.57
NGALAIK	340	44.98	45.08	33.60	46.03	66.78
YEZIN	36	47.15	50.19	39.19	52.94	75.[illegible]0
ZIBYUBIN	14	54.60	50.44	40.47	54.60	77.83
PAUNGLAUNG	1741	50.43	52.41	35.60	50.39	73.59
PALWE	122	48.07	55.45	33.88	47.36	65.10
CHAUNGMANGE	135	48.07	54.73	38 00	51.89	73.00
YONBIN ①	166	48.07	50.25	36.33	50.10	69.84
YONBIN ②	105	54.60	53.43	40.47	54.60	77.83
YENI	103	54.60	63.23	40.47	54.60	77.83
SWA	421	62.77	66.96	47.42	71.29	117.66
SAING	145	65.93	66.65	44.45	68.95	105.00

NOTE:-

COL. 2- AREAS ABOVE DAM LOCATIONS
COL. 5- BASED ON MINIMUM ANNUAL RAINFALL.
COL. 6- BASED ON AVERAGE ANNUAL RAINFALL.
COL. 7- BASED ON MAXIMUM ANNUAL RAINFALL.

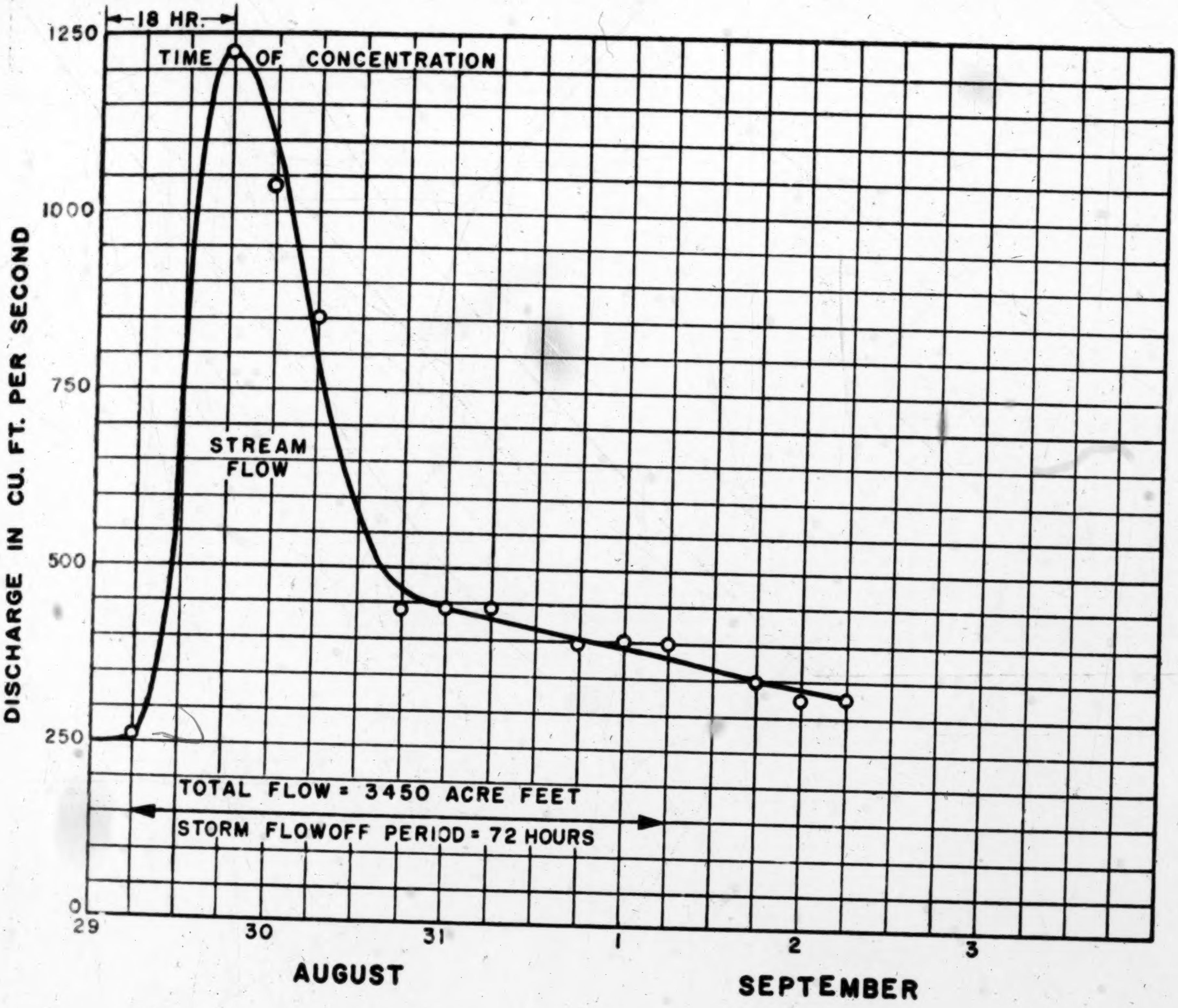
MINISTRY OF NATIONAL PLANNING

YAMETHIN DISTRICT IRRIGATION PROJECT

DRAINAGE BASINS
THEISSEN AND ISOHYETS MAP

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEWYORK. RANGOON.

DR BY F J P
CK BY A.R.R.
DATE MAY 1953.
PLATE NO 25



$$\text{RUNOFF} = \frac{3450}{\frac{3.51}{12} \times 36 \times 640} = 0.512$$

HYDROGRAPH DATA FOR 3·51-INCH
STORM OF 29 AUG., 1952 FOR 24 HOURS
OVER YEZIN D. A. 36 SQ. MI.

DATE	TIME	C. F. S.
AUG. 29	6 P.M.	260
AUG. 30	6 A.M	1225
	12 P.M.	1035
	6 P.M	850
AUG. 31	6 A.M.	443
	12 P.M.	443
	6 P.M.	443

DATE	TIME	C. F. S.
SEPT. 1	6 A.M.	400
	12 P.M.	400
	6 P.M.	400
SEPT. 2	6 A.M	350
	12 P.M.	328
	6 P.M.	328

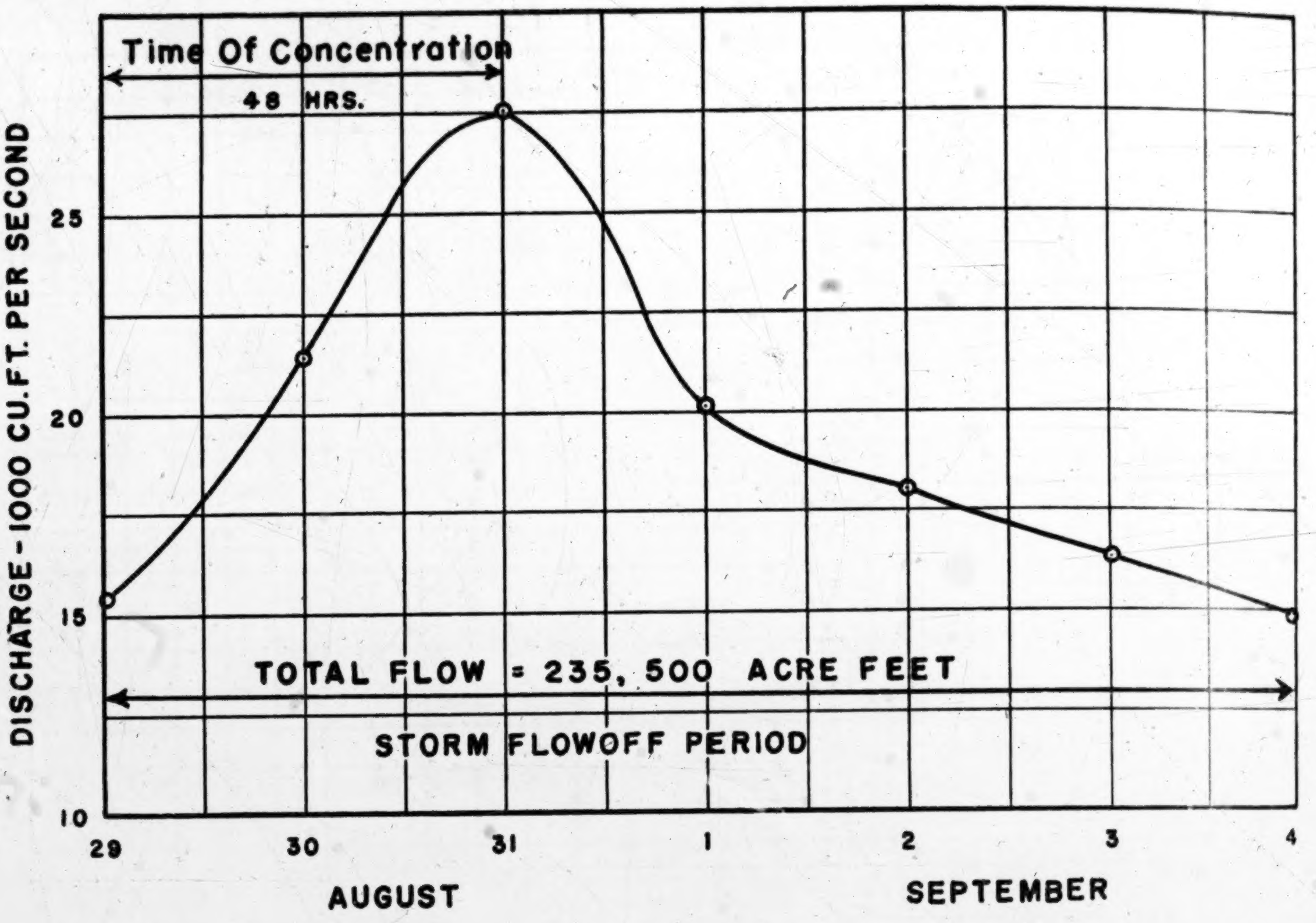
MINISTRY OF NATIONAL PLANNING

YAMETHIN DISTRICT
IRRIGATION PROJECT
STORM HYDROGRAPH
ON YEZIN

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. G. [illegible]. DATE PLATE
CK. BY. A.R.R MAY, 53. NO. **26**

R.B.--15



HYDROGRAPH DATA
3.51" STORM - AUG 29, 1952.
PAUNGLAUNG D.A. = 1741 SQ. MI.

DATE	FLOW	
AUG. 29	15460 C.F.S.	
30	21420 "	
31	27500 "	*
1	20090 "	
2	18000 "	
3	16400 "	
4	14920 "	

* ESTIMATED

$$\text{Runoff} = \frac{235,500}{1741 \times 640 \times \frac{3.51}{12}} = 0.72$$

MINISTRY OF NATIONAL PLANNING

YAMETHIN DISTRICT
IRRIGATION PROJECT
STORM HYDROGRAPH
ON PAUNGLAUNG

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.W. DATE
CH. BY A.R.R MAY 53
PLATE NO 27

may be used as a basis for comparing estimates of peak flows used in the project designs. The data are shown in Table IX–14.

TABLE IX – 14

RECORDED PEAK FLOOD FLOWS

Meiktila Lake Drainage Basin. Area 240·5 sq. mi. 5·56 inches in 7 hours at Meiktila, Sept. 11, 1910.

Date of Storm	*Total Rainfall*	*Lake*	*Inflow*	*Runoff*	
		Total Acre Feet	*Peak c.f.s.*	*Per Cent*	*c.f.s. per sq. mi.*
Oct. 2– 9, 1900	10·97	56,100	16,000	40	67
Nov. 5–12, 1908	9·56	48,700	20,000	40	84
Sept. 10–12, 1910	4·28	30,900	44,640	57	188
May 3– 6, 1920	8·04	25,505	75,120	25	315
Oct. 13–15, 1921	4·07	33,136	52,800	63·4	222
Oct. 23–26, 1926	7·21	45,519	31,224	49·5	131
Nov. 4– 8, 1935	11·00	95,075	129,612	67·6	545

Nyaungyan Tank Drainage Basin. Area 450 sq. mi. Sept. 11, 1910. Storm 5·56 inches 2 a.m. to 8 a.m.

Time	*Max. Flow c.f.s.*	*c.f.s. per sq. mi.*
6 a.m. to 8 a.m.	31,266	69
8 to 9	57,844	128
9 to 10	57,455	128
10 to 12	93,700	208
12 to 1 p.m.	116,389	258
1 p.m. to 2	86,309	192
2 to 5	60,251	134
5 to 6.30	54,984	122
6.30 to 9	49,756	110
9 to 10	69,290	154

Data on the Nyaungyan Tank were taken from "Irrigation Pocket Book," compiled by Robert Burton Buckley, CSI, Chief Engineer Indian Irrigation Dept. (retired).

Thitson Chaung Drainage Basin. Area 145 sq. mi. 5·22 inches in 24 hours, Nov. 3, 1935.

Flood 1917: 18,000 c.f.s.; max. flow, 124 c.f.s. per sq. mi.
Flood 1935: 13,300 c.f.s.; max. flow, 92 c.f.s. per sq. mi.
Flood 1948: 16,000 c.f.s.; max. flow, 110 c.f.s. per sq. mi.

Zawgyi River Drainage Basin. Area 1,578 sq. mi.
90,000 c.f.s.; max. flow, 57 c.f.s. per sq. mi.

Paunglaung River Drainage Basin. Area 995 sq. mi.
80,000 c.f.s.; max. flow, 80 c.f.s. per sq. mi.

(3) Use of Data

The available data are not all directly usable but may be a basis for establishing assumptions and criteria.

All the meteorology data are sufficient for use in the project planning. The valley rain-gauge stations are in the same general vicinity as the agricultural land; therefore the records are applicable for establishing water requirements over and above the natural supply.

The mean average rainfall determined by the Theissen method was used to compute the yield from the drainage basins of the various streams. No allowance was made for the possible increase in the amount of rainfall which may have occurred in the mountainous areas of the basins because there is no way of determining the increase. The value used is conservative, and since the use distribution of the irrigation water is based on the supply of water from this rainfall, the planning is on the conservative side. Should there be more rainfall, the water use allocation per acre may be increased or the acreage served may be expanded. The reservoir volume required for the estimated yield established the height of the dam, therefore a greater yield because of more rainfall in the drainage basins will further guarantee the storage supply for the land represented by the reservoir capacity.

The available data are insufficient to compute runoff factors. Comparison of the drainage basins of the project with those of similar characteristics and known runoffs has made it possible to establish the runoff factors shown in Table IX–11, column 4. These are also believed to be conservative, and if actual flows prove them to be low it will only tend to make the project more feasible, since the economic benefits are proportional to the acreage for which sufficient water is available.

The rainfall, runoff factor, and time of runoff are important for estimating peak flows for spillway designs. This design feature of the project planning cannot be based on a low estimate of these values. The spillways at each of the reservoirs are designed for storms occurring when the reservoir is full; therefore capacities must be large enough for maximum requirements. This being at the end or near end of the rainy season the use probability factor is reduced but nevertheless the provision must be made for the unusual storm which may occur at that time. Since all the records are incomplete, design assumptions were established as follows:

(a) A maximum single 24-hour storm of record is projected on the drainage basin with a runoff of 70%.

(b) The dam is designed with additional height to absorb this total inflow above normal water surface (NWS) shown on the plates for the various stream developments.

(c) The spillway design assumes this inflow will be discharged in 72 to 144 hours, depending on the drainage basin size, with peak discharge three times the average. Additional spillway capacity is available if required, through the tower control outlet structure and limited use of the freeboard on the dam, over and above that provided for rise over the spillway sill.

(d) At such time as operation experience and more exact and detailed data make possible closer control, gates may be added to the spillways for greater reservoir storage capacities and flood control, and more water supply carry-over to seasons of below-normal rainfall. The rainy period evaporation losses and the rainy season supplemental irrigation discharges may also be recovered in this way. The installation of such gates, however, will necessitate close operation at all times and special watchfulness and storm predictions during the rainy season.

d. The Land

Nearly 75% of the project area is presently devoted to paddy production, and the major portion of this is under paddy monoculture. A considerable acreage of the Yamethin District, which is the northern half of the area, is dependent on supplemental water from small stream diversion sources.

The land of this project area which is to be irrigated under the over-all development was given rather detailed study leading to general soil classification and agricultural recommendations. This study was attended by limitations in regard to time and agricultural literature and data available, collection of field samples because of the unrest in the country, laboratory facilities and personnel. The lack of research into new crops for Burma imposed a serious limitation in the preparation of crop rotation plans. Studies were made, however, leading to quite accurate conclusions for the project, and establishing a plan of procedure for continued studies.

The classification of soil was based upon the soil profile, surface texture, slope and other characteristics. Soil profile data were considered in terms of its derivation, age and degree of weathering, permeability at varying levels, and whether of primary or secondary formation. A Geologic Soil Map (Plate 24) was used for the determination of part of this information and laboratory tests supplied the remainder. Surface soil textures were determined by physical analyses in the soil laboratory. Slopes were estimated from aerial photographs of the area. Drainage requirements, the erosion status of the soil, and micro-relief characteristics were taken from aerial photographs. The presence of alkali, pH value, and the soil nutrient levels were investigated in the soil laboratory.

Soil profiles were characterized generally by low surface and subsoil permeability. The soils consist almost wholly of secondary formation alluvium and similar heavy clays of the Irrawaddy Series. Surface textures vary widely with the principal characteristics of an impermeable, or nearly impermeable, subsoil overlain with surface soils of somewhat lighter texture. Slopes are generally ideal with small intervening areas of rough topography.

The soil pH was found to vary from an extremely acid reaction in the south to neutral in the north. Soil nutrient levels varied widely with differing soil types examined. In general there was a nitrogen and a phosphorus deficiency. Potassium ions were not present in detrimental quantities. In general the magnesium-replaceable calcium levels were in good balance.

With due consideration given to each of the soil characteristics determined, a classification of soil into grades was made. Soil grading was based upon a numerical ratio of each soil sample analyzed, giving values to the soil characteristics examined. Grade I soil is suitable for a wide range of crops, with only the surface soil texture acting to limit the crop types. Grade II is soil suitable for most crops with one or more factors tending to favor certain crops and reduce the growing of others. Grade III soils are those having pronounced characteristics that combine to restrict or exclude certain crops. Grade IV is poor soil suitable for very few crops or a single one.

One hundred and fifty soil samples were taken in the project area. At each of 65 locations a surface sample was taken together with a sample of the subsoil. Ten locations were bored to a 6-foot depth with samples taken at each foot. Plates 28 to 30 inclusive are the soil maps for this project.

The determination of irrigation requirements was made in detail, taking into consideration crop types and soils on which grown, and the consumptive use of water for each crop. The Blaney-Criddle method was used for determining consumptive use and irrigation requirements of the actual crops to be grown. This method gives consideration to daytime hours and to temperature as does the general method for a whole valley discussed heretofore in Section A-3-b of this chapter.

Table IX–15 lists the crop irrigation requirements. The factor "K" is a consumptive use coefficient developed from actual measurements of consumptive use in tank and soil moisture field studies in the United States. The values have been modified to meet humid climatic conditions of the southeastern area of the United States and are considered valid for use in Burma under equivalent conditions of humidity and latitude. "U" is the consumptive use of water by the crop, in inches, for the growing season specified. "R" indicates rainfall in inches over the project area. "RE" is the effective rainfall over the area. Topography, soil, vegetative cover, rainfall intensity and other factors were considered in arriving at a determination of effective precipitation. The relatively flat terrain throughout the project area was considered to lose 5% of the rainfall as runoff waste. Predominantly heavy soils of the area were calculated to lose 3% of the rainfall to percolation waste. It was considered that 5% would be lost due to the type and density of the vegetative cover. Surface runoff losses due to rainfall intensity were considered to approximate 17% and those of other causes 7%. It is calculated that 63% of the rainfall will be used by crops. "I" indicates the amount of irrigation water, in inches, that must be supplied to crops for optimum growth. Thirty per cent losses of water supplied to the crop have been calculated to occur. It is considered that half the loss will be to surface runoff, and the other half to deep percolation.

All crops planned for the project area appear in Table IX–15 together with growing period and irrigation requirement information. The rainfall differs considerably from north to south, therefore the relative irrigation requirements have been calculated separately for the northern and the southern portions. The letters "N" and "S" in the table represent this division. Locations in between are a variation from one to the other. Detailed studies and programs for crop rotations, considering only those crops grown in Burma at this time, were made and the maximum water requirement in one month of the crop season was found to be from 10 to 12 inches.

e. Project Plan

All the details shown on General Plan Plates 21 to 23 inclusive are general, the planning prepared principally by use of one inch to the mile scale maps with contours at 50-foot intervals, and from field reconnaissance. Field surveys were made of the reservoir areas on the Yezin Chaung and Kyeni tank, topography and centerline of the dam site on the Thitson and Yezin Chaungs and Paunglaung River and centerline at the lower dam site on the Sinthe Chaung. Foundation investigations were not made at any of the dam sites except the Thitson Chaung which was made in 1931 and is neither conclusive nor complete.

A description of each development unit of the over-all project is as follows:

(1) Thitson Chaung Development

The Thitson Chaung has been a source of water for irrigation in the area north and west of Yamethin in the past. The supply was limited, however, to natural stream flow, diverting only if the water was available when needed. The disused system, known as the Teinnyetkon Canal and its distributaries, at one time served a small area between the Thitson and Shweda Chaungs, diverting from the Thitson Chaung just

TABLE IX – 15

CROP IRRIGATION REQUIREMENTS

(in inches)

Season	*Crop*	*"K"*	*"U"*	*"R"*		*"RE" (63%)*		*"U"—"RE"*		*"I" (70%)*	
				N	*S*	*N*	*S*	*N*	*S*	*N*	*S*
June 1–Nov. 25	Rice	1·00	40·9	27·8	69·1	17·6	43·5	23·4	6·6	33·7	9·4
Jan. 1–Apr. 15	Rice	1·00	21·8	1·4	1·2	0·9	0·7	21·0	21·1	30·0	30·2
Jan. 14–Apr. 15	Sesamum	0·65	12·4	1·4	1·2	0·9	0·7	11·6	11·7	16·6	16·7
Dec. 15–Mar. 15	Sesamum	0·65	11·2	0·6	0·3	0·4	0·2	10·9	11·1	15·5	15·8
Dec. 1–Feb. 28	Maize	0·70	11·5	0·7	0·3	0·4	0·2	11·1	11·3	15·9	16·2
Jan. 1–Mar. 31	Maize	0·70	12·6	0·4	0·2	0·2	0·1	12·4	12·5	17·6	17·9
June 1–Oct. 31	Garden	0·55	19·8	26·6	68·0	16·8	42·3	3·5	—	5·0	—
Dec. 1–Apr. 30	Garden	0·55	17·1	2·9	2·3	1·8	1·4	15·3	15·7	21·9	22·4
Jan. 1–June 30	Sugar Cane	0·70	28·7	12·4	22·2	7·8	13·9	20·9	18·1	29·8	25·8
July –Dec. 31	Sugar Cane	0·70	27·9	23·8	55·8	15·0	35·2	13·0	7·4	18 5	10·6
June 1–Oct. 31	Pulses	0·60	21·6	26·6	68·0	16·9	42·8	7·1	—	10·1	—
Nov. 1–Mar. 31	Pulses	0·60	17·7	2·3	1·7	1·4	1·0	16·2	16·7	23·1	23·7
June 1–Oct. 15	Groundnuts	0·65	21·3	24·3	64·6	15·3	40·7	6·2	—	8·9	—
Oct. 1–Feb. 15	Groundnuts	0·65	17·1	6·5	8·4	4·0	5·2	13·0	11·8	18·6	16·9
Dec. 15–Apr. 15	Tobacco	0·60	13·5	1·7	1·3	0·6	0·6	12·9	12·9	18·4	18·5
Nov. 15–Apr. 15	Cotton	0·55	16·6	2·6	2·0	1·6	1·2	15·0	15·4	21·5	22·1
Dec. 1–Mar. 31	Wheat	0·60	14·1	0·9	0·4	0·5	0·2	13·6	13·9	19·3	19·8
Jan. 1–Apr. 30	G. Manure	0·65	16·7	2·5	2·2	1·5	1·3	15·1	15·4	21·6	21·9
June 1–Oct. 15	G. Manure	0·65	21·3	24·3	64·6	15·3	40·7	5·9	—	8·5	—
Jan. 1–Apr. 30	F. Grass	0·65	16·7	2·5	2·2	1·5	1·3	15·1	15·4	21·6	21·9
June 1–Oct. 15	F. Grass	0·65	21·3	24·3	64·6	15·3	40·7	5·9	—	8·5	—

above Ainbok village. The diversion weir was destroyed and the canal system has been in a bad state of repair for many years. This source of water will be redeveloped for irrigation of lands previously served and for an additional area of arable land west of Yamethin which is too high for service from any other water source.

The development will include the construction of a dam across the Thitson Chaung approximately six miles above the old weir location for storage of all the runoff, a diversion dam at the old location, rehabilitation of the old Teinnyetkon Canal, and enlargement of the old Zidaw Distributary for a supply canal to extend eastward across the Shweda Chaung toward Yamethin and in a southerly direction therefrom at an elevation approximately on contour 750. A low embankment constructed across the Shweda Chaung valley will catch all runoff from that chaung and form a small reservoir through which the proposed supply canal will be carried. Water not used from this supply canal will be wasted at its terminus through a connecting canal to the Sinthe-N Canal leading northerly from the Sinthe Chaung reservoir.

A geological report dated March, 1931, by Dr. Coggin Brown for a dam site on the chaung some 12 miles northwest of Yamethin and about one mile above the old Teinnyetkon weir location was adverse to the site but suggested the possibility of a more suitable one farther west in the Pegu formation. A later geological study and report of a site approximately six miles upstream, including the digging of test pits and alignment surveys, is on the dam location for this project. The location is in the more solid rocks of the Pegu formation and although the geological report is not entirely favorable, the investigations that were made do not show conclusive data nor are they sufficient to substantiate the opinion. Under present-day knowledge of dam construction, difficulties much greater than those indicated in the report can be overcome. Before the preparation of design plans however, it is recommended that more detailed and complete investigations of the site be made.

These investigations and field surveys should include an alternative site at the old weir location. Should the alternative site be found satisfactory for the storage dam, the diversion works would be unnecessary and the over-all cost reduced.

(2) Sinthe Chaung Development

Although the Nawin Chaung may be considered the source of the Sittang River, the Sinthe Chaung rising in the Pegu Yomas and entering the valley some 20 miles southeast of Yamethin is the first major tributary. It joins the Nawin Chaung near Shwemyo Bluff on the Mandalay trunk road, and the combined flow continues therefrom under the name of the Sinthe Chaung. The catchment area is not large but the total flow for a season represents a supply of great value for irrigation of lands in the vicinity.

The waters of the Sinthe Chaung have been considered for irrigation on a number of occasions in the past. A small irrigation system existed years ago but was never satisfactory because diversion was possible only when the chaung was in flood. Reconstruction of this system was considered in about 1927 to irrigate an estimated 16,000 acres, but the plan did not materialize because of the intermittent water supply in the river, and because the relative levels of the ground and river were such that a high crest wall was required on the diversion weir to command the relatively small area.

The Sinthe Chaung development provides for the construction of two dams, one at each range of hills through which the chaung passes before it enters the valley. The dam in the upper range of hills is to be a concrete structure with an overflow spillway and sluice gates to supply the lower reservoir. All of the water stored above the upper dam will be usable for irrigation and will be released to the lower reservoir as needed. The dam at the Myaukhmyaik village site is to be rolled earth fill with a concrete spillway structure and canal headgate at the left abutment, a concrete canal headgate structure at the right abutment, and a concrete tower control outlet structure for low-level releases into an old existing canal system.

Two canals carry water from the lower reservoir, one northerly named the Sinthe-N Canal, and the other southerly named the Sinthe-S Canal. These canal locations were made with a view to commanding all land that appeared to be topographically suited for irrigation from the base of the foothills to the low point of the valley. Field surveys were not possible because of the unsettled conditions in the area.

The Sinthe-N Canal will follow the contour for gravity flow to a point near Kyabin-in village, where a pump installation will raise the water to a higher level canal for continuation to lands around and north of Yamethin. This canal system will also feed the Kyeni tank operation at the southeast corner of Yamethin. The high-level canal will continue north to the Shweda Chaung, supplementing various small systems along the way, including those from the Kyeni tank. Two secondary canals will extend from the Sinthe-N Canal; one to continue northeasterly on the contour below the pump station, crossing the highway, railway and the Nawin Chaung for command of an area on the east side of the valley; the other canal branching off above the pump station and to continue at a high level across the Nawin Chaung along the south embankment of the Kyeni tank. This high-level branch will serve the area between the two branches, supplement the Kyeni tank supply and connect with an existing high-level canal along the foothills east of the Samon Chaung.

The interconnection of the distribution system from the Sinthe development with the Kyeni tank and other small irrigation systems around Yamethin, will firm the water supply for the whole area and make possible more economical use of all the natural water resources.

The Sinthe-S canal location will follow the contour southward from the reservoir to a point near Pyokke village. The terrain through which the lower end of this canal will be located is very rough but by damming streams to provide lakes through which to carry the water instead of using flumes or siphons, and constructing drops into these small lakes to lower the canal level as the slope of the land decreases southward, construction difficulties will be reduced.

The project includes the improvement of the existing Kyeni tank facilities, not only physically but also by correlation with the Sinthe Chaung irrigation canal system. Improvements will be made in the collection system which supplies the tank, to increase the catchment area and the amount of runoff intercepted. The embankments of the tank will be raised so that the capacity will be increased to approximately 18,000 acre feet. Close control of the releases from the tank, together with the water supplied from the Sinthe Chaung canals, will make it possible to serve the area adequately. All the yield from the small drainage areas supplying the tank can be controlled and used.

The construction on the Kyeni tank is principally the raising and extending of the existing embankments to increase the capacity of the tank, and to decrease the leakage at the north embankment. Evidence indicates that the present bund was constructed without adequate bonding to the original ground. At the highest portion of the north embankment leakage is evident and there has been slippage of the downstream face. The south embankment is to be increased in height sufficient for one bank of the irrigation canal.

There has been very little field information on either of the two dam sites on the Sinthe Chaung. The upper location is in a narrow valley with steep banks, especially on the right. The existence of this narrow neck connecting two separate valleys suggests very hard material. A concrete dam is planned for this site because the foundation material appears to be suitable for such a structure and also because it is desirable to construct the spillway integrally with the dam.

The lower dam site is at the wide outlet from the lower range of hills. Reports are that the base is entirely of sand for a considerable depth. Tests were made with a pressure bearing rod which theoretically indicates the location of harder materials at the depth where the pressure shows an increase. These high pressures were recorded at approximately 30 feet depth along the dam centerline. Test pits to check the accuracy of these findings were not made.

Detailed investigations of the dam sites and field surveys for the entire project will be necessary before design plans are prepared. An alternative plan for one dam on the Sinthe Chaung at the upper site, with the canals running therefrom, should be studied. This will require surveys for canal and structures locations in sufficient detail to make comparative cost estimates.

(3) Yezin Chaung Development

A canal system running southerly on the ridge between the Yezin and Sinthe Chaungs is now supplied for supplemental irrigation from a temporary-type diversion structure on the Yezin Chaung at the southern end of Yezin village. The yield from the drainage basin of the Yezin Chaung is limited because of the small area. There is some flow throughout the year as evidenced from the recorded flow shown in table IX–12, but rather than construct a permanent diversion structure for natural stream flow, a dam to form a reservoir for the total yield is part of the project plan.

All the agricultural area accessible to the Yezin Chaung irrigation development cannot be served from that source because of the inadequacy of the water supply. A canal distribution system for the entire area on both sides of the Sinthe Chaung has been planned with a supply canal connecting the Yezin Chaung reservoir and the Paunglaung River for the additional water required. The water supply and use distribution Table IX–11 shows in column 12 a total area under the Yezin Canal system of 56,250 acres, 20,780 of which are served from the Yezin Chaung source and 35,470 acres from the Paunglaung River source. Column 10 shows the water supply available from each source and column 17 the water required to serve the acreages adequately. The additional water needed to serve the entire agricultural area on both sides of the Sinthe Chaung is thus supplied from the Paunglaung River during period of excess in that river. The impounded flow of the Yezin Chaung is held in storage for use when the Paunglaung River supply is not available.

A pump lift is provided in the Yezin Canal on the west side of the Sinthe Chaung to raise water for delivery to higher-level land north of Kyidaunggan village.

(4) Paunglaung River

The development of the Paunglaung River is definitely for multi-purpose irrigation and hydroelectric power. Its place in the irrigation development of the entire Yamethin district irrigation project is very important, as is evidenced by the General Plan, Plates 21 to 23 inclusive. In addition to making possible the irrigation of 35,470 acres under the Yezin Chaung development as discussed heretofore, the water supply in the river below the hydroelectric installation will make possible pump installations to irrigate 72,240 acres, and the generation of electrical energy will supply cheap power for the pump installations on the river, the canal pump lift in the Yezin Chaung system for 9,240 acres, the canal pump lift in the Sinthe Chaung system for 39,500 acres and the well irrigation, discussed later, for 73,500 acres. The construction of a concrete dam and the hydroelectric generating equipment on the river at a site approximately three miles above Kyidaung village will provide all these facilities as well as furnish power through transmission lines to villages for domestic and industrial use up and down the valley. This water resource is in an advantageous position at the half-way point of an over-all valley development.

The storage capacity of the reservoir created by the dam on the Paunglaung River will be insufficient to store all the yield from the drainage area because of the narrowness of the valley. The runoff measurements recorded in Table IX–13 show a high stream flow for most of the year. Storage is needed at the present time only for carry-over during the low flows and for head to develop power. Additional storage may be developed up river at a later date when the demand for power increases.

The supply canal to the Yezin Chaung dam will be served from a gate in the right abutment of the dam. Water will flow from the reservoir for the total Yezin system irrigation during the months of excess supply in the Paunglaung River. The yield from the Yezin Chaung drainage basin will be held in reserve for use when needed, the Yezin storage acting as regulation for the system.

The pump installations on the river bank at the various locations from the river's entry into the valley southerly to Toungoo are planned for operation during a 10-hour period to coincide with the peak power generation. This will assure a sufficient water supply by release from the reservoir, even during the period of present low natural stream flow.

The geological report on the dam site was favorable in every respect. The dam site and the eastern and western portions of the reservoir basin are occupied by granites and mixed gneisses which have been formed by the intimate association of the granitic material with the rocks of the coal measures and are found near the junction of the granites with the coal measures. It is in an area of exposed bedrock with the flanks covered by residuum from rock decay and tanks. A saddle for use as a spillway is at the left abutment.

The reservoir site is underlain by rocks which are more or less impermeable except for limestones. Their position, structure relation to granite, and the topography of the area suggest that there is little chance of leakage through the limestone formation.

Provision for earthquake effects must be made in the dam design. The location is near a major boundary fault line between the crystalline rocks of the Shan Plateau on the east and the tertiary rocks on the west. Many earthquakes have been attributed to movements along this fault line.

The details of the hydroelectric development on this river are discussed in Chapter XIX.

(5) Ngalaik Chaung Development

West of Pyinmana, a stream originating in the Pegu Yomas emerges on the plain and discharges into the Sinthe Chaung east of Pyinmana. The entire yield is now wasted except for minor diversions above Pyangabye village. The development of this water resource for irrigation is planned to be effected by the construction of a dam at the narrow point of the valley west of Pyangabye village to store the flow in a reservoir. A natural saddle for the location of a spillway exists east of the dam site. The canal distribution system from the reservoir will command all the area on the west side of the Paunglaung River from Pyinmana south, crossing the Yonbin and Yenee Chaungs southerly to Yeni village.

Consideration was given to the development of the Yonbin Chaung, but it was abandoned because the reservoir would inundate the railway running up its valley. The water supply from the Ngalaik Chaung is sufficient for the entire acreage in the area, consequently the development of either the Yonbin or Yeni Chaungs was not necessary.

Foundation investigations and surveys will be required before design plans can be started.

(6) Saing and Swa Chaungs Development

The Swa Chaung of which the Saing Chaung is a branch, is the southernmost water resource for development in the project. The total yield from this large drainage basin now flows freely into the

Paunglaung River, often flooding the agriculture land and causing damage to the railway and highway during flood periods. Construction of a dam across these streams to form a reservoir for storage of the runoff will provide not only water for irrigation but also flood control.

The confluence of the Saing and Swa Chaungs is outside the range of hills from which the chaungs originate, consequently a single dam could not be built across the Swa Chaung for both streams. The two dams are planned as a continuous embankment, forming two reservoirs. Saddles make natural connections between the two reservoirs, and another saddle beyond the right abutment of the Swa Chaung dam provides a spillway location for the entire drainage basin area of both chaungs.

The area commanded by the irrigation system from the Swa Chaung reservoir lies entirely on the west side of the valley south of the east-west route of the Swa Chaung as it flows to the Paunglaung River. The area commanded by the irrigation system from the Saing Chaung reservoir lies entirely on the west side of the valley, north of the east-west route of the Swa Chaung as it flows to the Paunglaung River. There is sufficient yield from both drainage basin areas to serve adequately all the area from Yeni village south to Toungoo with enough excess for log sluicing from the reservoir. The spillway will be provided with sluice gates for this purpose.

Foundation investigations have not been made at this dam site.

(7) Well Irrigation Development

Surface water supply is not available for all the arable land in the project area north of Tatkon. Along the base of the Shan Hills, on the east side of the valley from Tatkon north, are hundreds of acres on which irrigation is not practiced. The water supply is limited to small streams, tanks, and rainfall collected in the bunds. The well irrigation development, as a unit of the Yamethin irrigation project, provides for the tapping of the subsurface water supply to irrigate this area properly.

Data gathered on existing open wells, and the fact that stream flow from the Shan Hills is practically continuous throughout the year, indicate the possible existence of a good underground water supply. Investigations of the dry streams may also disclose underground flow which could be tapped by means of infiltration galleries.

The proper depth, size and spacing of wells can be determined only by test wells and borings. This information will determine whether the wells will be individual installations or an interconnected series discharging into a main canal from which a distribution system could be constructed. The estimate of cost for this report is based on one installation for every 160 acres and a lift of 30 feet. If it is found that infiltration galleries in the water courses are feasible after field investigations are made, the cost of such construction would be much lower.

The wells are to be bored or drilled and lined with steel casing perforated where it passes through or extends into the water-bearing sand and gravel. Only the main supply canals are included in the construction estimate where pumping units are planned to operate together. Independent pumping units will be necessary for small isolated areas. These have been estimated at 30% of the total pumping requirements.

Power for the operation of the pumps for this development was discussed under the Paunglaung River development. Until such time as this power is available, dual drive heads may be provided on the pumps for conversion to electric drive later.

3. KANDAW VILLAGE IRRIGATION PROJECT

The Kandaw village project is shown on General Plan Plate 31. The plan shows the dam and reservoir location near Kandaw village about 15 miles west of Pakokku, data pertinent to the reservoir capacity, canal locations, areas to be served under each canal division, drainage basin for the reservoir water supply, the general topography and other physical features of the whole area. The source of the water supply and its use distribution is shown in Table IX–17A (*see p.* 236), a detailed explanation of which is found in the third paragraph of Section B.

a. Present Economy

The area that will receive benefits from the project by increased agricultural production through irrigation and domestic water from the storage reservoir is in Pakokku District. It is strictly agricultural with incomes derived entirely from agricultural production. Very few of the living necessities are purchased outside the area, and the everyday clothing is spun from raw cotton grown and prepared by the villagers.

The rainfall is very low, averaging approximately 25 inches annually. This falls in flash showers with the result that its full value is not received. During the long period of the dry season, members of each of the village families spend much time and effort in carrying and transporting water for domestic use.

Pakokku town, with a population of 29,824, is about 15 miles east of Kandaw village. The whole area shows the influence of the early history centered about Pagan some 40 miles downstream. It is said that race-horse breeding was an important business before the war, and many of the race-horses were brought to the area from Rangoon because of the dry climate.

Production is low in Pakokku District, and the acreage abandoned because of crop failure is high. Groundnuts are the main crop as shown with other information on the main crops in Table IX–9.

Kandaw, Kanyat, Kandein, and Kangyingon villages, situated around the project storage reservoir, will benefit from the water for domestic use.

b. Geology

The sand rock, sandstones and clays of the Irrawaddian Series have a very extensive distribution. The project area is alluvial, with Irrawadian materials in the drainage basin of the stream source and extending southward into the upper end of the cultivated area. The soil is a reddish fine sand with a small amount of clay silt. The general area from Pakokku to Kandaw is rolling hills with rather deep gulleys and stream courses pointing to the Irrawaddy River. Small valley areas and ridges between the gulleys make up the cultivated acreage. The project area is one of these valley areas.

c. Local Natural Conditions

(1) Meteorology

The southwest monsoon current travels over a wide expanse of land from the west before it reaches the Pakokku area. Pakokku is somewhat north of the direct path of the monsoon and the rainfall at the Arakan coast directly west of the project area is less than farther south, indicating less moisture carried by the air current as it starts over the Yomas and Chin Hills dividing India and Burma. The moisture is lost rapidly as it crosses this land area so that by the time Pakokku is reached not much is left, and the rainfall for the area is very low.

(2) Hydrology

The rain-gauge station at Tabya seven miles from Kandaw village records an average annual rainfall of 25 inches. This should be quite accurate for the drainage basin. The General Plan Plate 31 shows the drainage area of the stream supplying the project water storage. This is a very small area, and local physical evidence indicates a rapid storm runoff. The runoff factor was therefore estimated at 60%.

The estimated rainfall and runoff data for the supplemental supply from the Chaungmagaing Chaung are computed on the same basis as that from the Gwebin Chaung. Flow data are not available on either of the source streams, but it is quite certain that flow occurs only at a rainfall period, and that the stream is dry at other times.

(3) Use of Data

The data available were used as recorded for all the preliminary designs. The spillway design is based on a maximum single 24-hour storm record with a runoff of 80%. The dam is designed with sufficient height to absorb this total inflow above normal water surface and the spillway outlet to discharge this inflow within 72 hours with the peak discharge three times the average.

d. The Land

A number of soil samples, both surface and subsoil, were collected in the area to be irrigated. These were analyzed, as described briefly for soil classification in Chapter VIII on Agriculture, and approximately the same as for the Yamethin District irrigation project discussed heretofore. The land under this project was given rather detailed study leading to general soil classification and agricultural recommendations. The Soil Map (Plate 32) shows these classifications and the locations for each. The soil

TABLE IX – 16

KANDAW
CROP IRRIGATION REQUIREMENTS
(in inches)

Season	*Crop*	*"K"*	*"U"*	*"R"*	*"RE" (58%)*	*"U" – "RE"*	*"I" (50%)*
May 1–Aug. 15	Groundnuts	0·65	21·94	12·10	7·00	14·94	29·88
May 1–July 30	Sesamum	0·65	14·93	9·41	5·46	9·47	18·94
Aug. 1–Oct. 30	Sesamum	0·65	13·62	14·12	8·20	5·42	10·84
Aug. 1–Dec. 15	Groundnuts	0·65	19·22	15·51	9·00	10·22	20·44
Aug. 1–Oct. 30	Maize	0·70	14·68	14·12	8·20	6·46	12·92
Aug. 1–Nov. 15	Millet	0·60	14·34	14·77	8·55	5·79	11·58
June 1–Oct. 30	Pulses	0·65	23·44	20·69	12·00	11·44	22·88

grading was based upon a numerical rating of each soil sample analyzed, assigning relative values to the soil characteristics examined.

Four per cent of the soil in the area to be irrigated under the project was found to be sandy loams Grades I and II suitable for corn, millet and legumes; 60% was found to be sandy Grade III suitable for groundnuts and sesamum.

The determination of irrigation requirements was made in detail, taking into consideration crop types and soils on which grown, and the consumptive use of water for each crop. The Blaney-Criddle method was used for determining consumptive use and irrigation requirements of the actual crops to be grown.

Table IX–16 lists the irrigation requirements of the crops best suited to be grown in the area. The factors have been described previously in paragraph B-2-d. The relatively flat terrain throughout the project area was considered to lose 3% of the rainfall as runoff waste. Predominately sandy soils of the area were calculated to lose 10% of the rainfall to percolation waste. It was considered that 5% would be lost due to the type and density of the vegetative cover. Surface runoff losses due to rainfall intensity were considered to approximate 17% and those from other causes 7%. It is calculated that 58% of the rainfall will be used by crops. Fifty per cent losses of water supplied to the crop have been calculated to occur. It is considered that half the loss will be through surface runoff, and the other half to deep percolation.

Most of the soil is very rich and well adapted to groundnuts if water for irrigation is available and nitrogen fertilizer is added. It has been estimated that the per-acre yield could be increased four times over the present by addition of water and nitrogen and improved seed and cultivation methods.

The amount of water supplement to rainfall required per crop season is estimated at 20 inches, using the data in Table IX–16 and computed as follows:

Groundnuts	48 per cent	×	25·00	=	12·00
Sesamum	12 per cent	×	15·00	=	1·80
Corn	15 per cent	×	12·92	=	1·94
Millet	10 per cent	×	11·58	=	1·15
Legumes	15 per cent	×	22·88	=	3·44
	100 per cent				20·33

Only one crop per year is planned ~~for~~ because of the limited water supply. If it is found that the water supply is more than estimated, a second crop will add to the benefits.

e. Project Plan

All the details shown on the General Plan Plate 31 are general. The over-all planning was prepared by use of one inch to the mile scale maps and from field reconnaissance. A field topographic survey was made on the reservoir area and dam location. The reservoir capacity was calculated from this survey.

The source of supply and use distribution data contained in Table IX–17A (*see next page*), together with the General Plan Plate 31 are self-explanatory. The yield from the small drainage area supplying the reservoir may be insufficient for the reservoir capacity and the agriculture and village requirements. The project development plan includes the diversion of the flow of the Chaungmagaing Chaung east of the Gwebin Chaung, to the Kandaw Village reservoir. This feature of the project development could wait until the reservoir embankment is constructed and one or two years' operation gives more complete data on the area. On the other hand, the additional water supply source will increase the acreage served and provide a greater guarantee of the supply.

Only one crop per year has been scheduled under use distribution because of the small water supply and the large amount of water required to irrigate the sandy soil and to supplement the low rainfall. The project total cost is high as shown in the Estimate of Cost and Benefits Table IX–19, Section C of this chapter (*see p.* 242). Its justification may not be determined entirely from an economic standpoint, however, but the social, sanitary and living benefits brought to the villages in the vicinity should also be considered.

Complete field surveys and design plans may reduce the cost as estimated, but it is also suggested that test borings and studies of the underground water supply should be made to determine the possibility of the water being supplied from wells. If such a supply were found in sufficient quantity, the costly reservoir embankment shown in the project plan could be eliminated.

4. LOIKAW AREA IRRIGATION PROJECT

The general plan of this development is shown on Plate 33. The source of the water supply and its use distribution is shown in Table IX–17B (*see p.* 237), a detailed explanation of which is found in the third paragraph of Section B.

a. Present Economy

The project location is the Kayah State in the Shan Plateau. The Karen group of races (including Padaungs and Toungthus) make up three fourths of the population and most of the remainder belong to the Shan race. The Shans normally inhabit the valleys and much of the flat tableland, while the more primitive animistic tribes live in the hills, chiefly perhaps to avoid the malaria of the plains to which they are susceptible. The estimated population density is 16 per square mile with about 79,000 persons in the whole state.

Irrigation from mountain streams and lakes is fairly common, the rice growing in many places on step terraces high up the mountain valleys. The area is self-sufficient in rice. Groundnuts are common on the higher sandy ground. Other crops are oranges, papayas, vegetables, and maize. Other economic products are tin, teakwood and tungsten. The average rainfall at Loikaw for a 35-year period is 46 inches. The temperature ranges from about 46° to 91°F.

Transportation facilities in the valley are limited to the highway running north to south for the entire length, and to air travel. The locality is isolated to the extent that there is not an east-west road connection to the central belt of Burma except at Taunggyi, about 100 miles north of Loikaw. Future over-all developments for Burma include a proposed highway from Loikaw to Pyinmana.

b. Geology

The area in the trough between two ranges of hills, known as the Yawnghwe Valley, is typical of many of its kind in the Shan Plateau. Sediment washed in from the surrounding hills by short, fast-flowing streams has filled the original depression. The valley area lies at about elevation 2,900 feet.

Inle Lake lies at the northern end of this valley, occupying a low area that has not been entirely filled with sediment. Alluvial plains formed at its two ends are indicative of what has taken place in the whole valley over the course of time. Drainage into the lake is from both hill ranges, but the main flow is from the area north and west. All the silt brought down by the streams is deposited before it reaches the middle of the lake. It is probable that a large tract south of the lake was once under water and has been gradually filled in by the deposition of silt. The lake originally may have been a hundred miles long and several hundred feet deep.

TABLE IX – 17A

KANDAW VILLAGE IRRIGATION PROJECT
WATER SUPPLY AND USE DISTRIBUTION

1	2	3	4	5	6	7	8	9	10
	Drainage Basin				*Reservoir Storage (acre feet)*				
Source	*Area (sq. mi.)*	*Annual Average Rainfall (ins.)*	*Estimated Average Runoff (per cent)*	*Estimated Average Yield (acre feet)*	*Use Provision*	*Capacity*	*Evaporation Loss*	*Dead Storage*	*Net Available for Irrigation*
KANDAW VILLAGE									
Gwebin Chaung	18	*25	60	14,400	Reservoir	18,000	2,400	–	12,000
Chaungmagaing Chaung	11	*25	60	8,800	Diversion	—	—	—	8,800
Total	—	—	—	23,200	—	—	—	—	20,800

11	12	13	14	15	16	17	18
	Land to be Served			*Water Distribution (acre feet)*			
Location: Refer to General Plan	*Gross Acres*	*Net Acres Irrigated*	*Net Acres 2nd Crop*	*1st Crop Supplement*	*2nd Crop Total Irrigation*	*Total*	*Remarks*
KANDAW VILLAGE	15,600	12,500	—	20,800	—	20,800	Dry Season Crop not Planned

*Tabya rain-gauge station.

TABLE IX - 17B

LOIKAW AREA IRRIGATION PROJECT WATER SUPPLY AND USE DISTRIBUTION

1	2	3	4	5	6	7	8	9	10
	Drainage Basin				*Reservoir Storage (acre feet)*				
Source	*Area (sq. mi.)*	*Annual Average Rainfall (ins.)*	*Estimated Average Runoff (per cent)*	*Estimated Average Yield (acre feet)*	*Use Provision*	*Capacity*	*Evaporation Loss*	*Dead Storage*	*Net Available for Irrigation*
LOIKAW AREA									
Inle Lake	1,383	48	33	1,170,000	Gate control	—	—	—	170,000
Balu Chaung	1,185	46	33	960,000	Pump	—	—	—	*
Total	—	—	—	2,130,000	—	—	—	—	—

11	12	13	14	15	16	17	18
	Land to be Served			*Water Distribution (acre feet)*			
Location: Refer to General Plan	*Gross Acres*	*Net Acres Irrigated*	*Net Acres 2nd Crop*	*1st Crop Supplement*	*2nd Crop Total Irrigation*	*Total*	*Remarks*
LOIKAW AREA							
Namtok Canal	12,950	9,700	7,300	9,700	21,900	31,600	Pump
Pekon Canal	11,750	8,800	6,600	8,800	19,800	28,600	,,
East Loikaw Canal	9,000	6,800	5,100	6,800	15,300	22,100	,,
West Loikaw Canal	16,800	12,600	9,500	12,600	28,500	41,100	,,
Total	50,500	37,900	28,500	37,900	85,500	123,400	

*Flow available when needed.

The river which flows from the lake disappears underground and again emerges as the Balu Chaung which continues southward through the length of the entire valley and finds its way to the Salween River. Falls occur below Loikaw, but the river from the lake to Loikaw flows rather quietly through a wide valley with an occasional narrowing in the hills to form high stream banks.

c. Local Natural Conditions

(1) Meteorology

The southwest monsoon from the Bay of Bengal crosses the Arakan and Pegu Yomas until it strikes the Shan Plateau and the higher mountains between Burma and China. The wind then turns toward the north in a wide arc so that the wind direction over most of Burma is from the southeast during the monsoon period. As the period comes to a close, north winds gradually take over until the direction has completely changed. These northerly land winds continue until the monsoon returns again with its moisture.

The temperature records available are for the station at Loikaw during 1952. The maximum temperature of 91·1°F. occurred in April and the minimum temperature of 46·4°F. occurred in January. The minimum monthly variation was in July with 4·6° and the maximum in February with 36·3°. The mean monthly variation in temperature was 21·7°. Since evaporation is definitely influenced by temperature ranges, the characteristics of the cycle give some idea of the rate of evaporation.

Moisture transpiration is dependent on air movement and precipitation is therefore affected by the winds. The maximum monthly wind speed record at Loikaw in 1952 for an average of 24 hours was 4·9 miles per hour in August. Rainfall data of record for the same period indicate maximum rainfall in the same month.

(2) Hydrology

The rainfall data for the project area were taken at two stations, Loikaw and Yawnghwe. Both stations are in the valley, but since the drainage areas for the individual chaungs flowing into Inle Lake and Balu Chaung are small, and the valley itself is part of a great plateau, the records should be quite representative of the whole area. Rainfall records for the two stations are shown in Table IX–18.

Stream-flow records of the Balu Chaung taken at Loikaw for October, November and December, 1952, and January to June inclusive, 1953, are shown in Table IX–18. Records for July through September were estimated from a constructed flow curve using rainfall records for a 35-year period. There is sufficient natural flow in the river most of the year with possible storage during the months of April, May and June. These flows may be increased from Inle Lake storage if means of regulating the lake flow are provided.

Table IX–17B shows the estimated yield from both the Inle Lake drainage area and the Balu Chaung drainage area below the lake. The amount of runoff was determined as shown in Table IX–18. There is ample water supply from both sources for the project, and very little regulation would be required in the lake for the entire irrigation requirements not counting the flow in the Chaung.

The runoff as indicated by the stream-flow record is very low for the characteristics of the drainage areas. Geology of the area indicates the possibility that the water often disappears below ground, especially from a lake such as the one in the valley. The low stream flow at Loikaw would indicate that some of the water supply in the area is lost in this way, possibly feeding other streams flowing from the plateau.

d. The Land

Very few data are available regarding soil and production in the Yawnghwe Valley except for the information gained from field reconnaissance and discussion with local officials. The geology of the area gives some idea of the soil types. Most of the soil is a reddish sandy loam, possibly heavier in the valleys as evidenced by the paddy cultivation. Groundnuts, maize and even some paddy are grown on the upland slopes. Tall grass grows on the higher plateau areas.

The valley is well suited to livestock. Temperature, rainfall and altitude, together with rich upland areas for grazing and rich lowland for production of feeds, are ideal for such an industry. Gram and groundnut production combined with dairy and livestock would be an ideal combination.

e. Project Plan

The part of the project development by which the agriculture area is to be irrigated is shown on General Plan Plate 33. The water is to be raised from the Balu Chaung by pumping, with four installations, two on each bank of the river. These locations together with the canals, areas in acres to be served under each unit, the general topography, and other physical features of the area are shown on the plan.

All the details shown are general, the planning prepared entirely by use of one inch to the mile scale maps with contours at 50-foot intervals, and from information gathered on field reconnaissance and discussion with officials familiar with the area.

Diversion to canals by pumping was the means most suitable for the purpose because of the nature of the topography. A dam in the vicinity of the pump installations would flood good farm land above, and a dam above would require long canals to serve the area suitable for irrigation. A weir is planned for construction just below the pumps, however, for the purpose of regulating the water surface to a constant elevation as high as the chaung banks will allow without overflow. This will keep the pumping head constant and possibly as low as ten feet. (Actual head will require surveys before it can be determined accurately.)

The supply of water flowing in the Balu Chaung annually is much in excess of what will be required for two crops per year. This is clearly shown in Table IX–17B described heretofore. The months of April, May and June, however, may be deficient as shown by the stream-flow record, Table IX–18, if the chaung flow is not regulated. This regulation may be obtained by constructing control gates in the chaung near Samka village to hold back storage in Inle Lake for use during the months needed. This regulation could also be used for spreading out the supply in the chaung to increase the minimum flow for the hydro-electric installation proposed below Loikaw. Refer to Chapter XIX of the over-all report for this hydro-electric project discussion.

Information of record on Inle Lake indicates that the depth varies from 12 feet in the dry season to 20 feet in the rainy season. This would suggest

TABLE IX – 18

BALU CHAUNG

STREAM FLOW 1952 – 53

(thousands of c.f.s.)

Balu Chaung Drainage Area = 1,185 sq. mi. Inle Lake Drainage Area = 1,383 sq. mi.

	1953						*35-Year Record*			*1952*		
	Jan.	*Feb.*	*March*	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
1	1·26	1·04	0·75	0·47	1·04	0·35	Estimated discharge 31 days at 5·98	Estimated discharge 31 days at 6·52	Estimated discharge 30 days at 6·6	7·20	5·20	2·17
2	1·26	1·02	0·75	0·48	1·02	0·36				7·10	5·05	2·09
3	1·26	1·01	0·73	0·48	1·01	0·36				7·10	4·92	2·02
4	1·26	1·02	0·72	0·48	1·01	0·36				7·00	4·72	1·93
5	1·25	1·00	0·71	0·42	1·00	0·36				6·95	4·52	1·92
6	1·26	1·00	0·69	0·41	1·00	0·36				6·95	4·37	1·87
7	1·25	0·99	0·68	0·48	0·70	0·36				6·90	4·22	1·83
8	1·24	0·97	0·64	0·47	0·66	0·36				6·90	4·05	1·80
9	1·24	0·97	0·64	0·41	0·73	0·42				6·80	3·92	1·77
10	1·23	0·96	0·63	0·45	0·67	0·49				6·80	3·82	1·69
11	1·22	0·96	0·61	0·40	0·64	0·49				6·80	3·72	1·68
12	1·21	0·95	0·61	0·40	0·65	0·47				6·70	3·70	1·68
13	1·21	0·94	0·60	0·39	0·59	0·47				6·60	3·61	1·68
14	1·20	0·94	0·59	0·39	0·60	0·48				6·55	3·52	1·65
15	1·18	0·92	0·58	0·39	0·56	0·64				6·50	3·34	1·65
16	1·15	0·90	0·57	0·37	0·54	0·66				6·42	3·30	1·62
17	1·13	0·89	0·56	0·37	0·51	0·63				6·35	3·32	1·57
18	1·10	0·89	0·56	0·36	0·51	0·60				6·20	3·10	1·55
19	1·10	0·88	0·55	0·36	0·41	0·79				6·15	3·02	1·55
20	1·09	0·87	0·55	0·37	0·33	0·71				6·12	2·94	1·55
21	1·08	0·86	0·55	0·36	0·32	0·66				6·05	2·87	1·52
22	1·06	0·86	0·55	0·36	0·32	0·62				6·02	2·78	1·49
23	1·04	0·85	0·57	0·36	0·32	0·56				5·95	2·72	1·48
24	1·04	0·84	0·54	0·36	0·35	0·60				5·75	2·62	1·45
25	1·03	0·82	0·54	0·36	0·36	0·60				5·75	2·54	1·41
26	1·03	0·81	0·52	0·36	0·36	0·60				5·80	2·48	1·40
27	1·02	0·79	0·50	0·36	0·36	0·53				5·70	2·42	1·37
28	1·01	0·78	0·49	0·36	0·36	0·53				5·55	2·32	1·33
29	1·00	—	0·49	0·38	0·36	0·51				5·42	2·26	1·32
30	1·02	—	0·47	0·40	0·36	0·51				5·30	2·21	1·29
31	1·08	—	0·45	—	0·42	—				5·25	—	—
	35·51	25·73	18·39	12·01	18·07	15·44	185·00	202·00	198·00	196·63	103·48	49·33

RAINFALL IN INCHES

	Years Record	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Total*
Loikaw	35	0·18	0·22	0·49	1·66	5·68	6·66	7·41	8·16	7·92	5·04	1·96	0·67	46·03
Yawnghwe	33	0·07	0·19	0·42	2·12	6·79	5·79	6·99	8·91	8·31	5·18	2·39	0·51	47·67

Average rainfall = 3·9 inches.

$$\text{Runoff factor} = \frac{1059{\cdot}59 \times 1{,}000 \times 2}{3{\cdot}9 \times 640 \times 2{,}568} = 33\%.$$

that the lake could be regulated by at least the amount retained in eight feet without bringing hardship to present occupants of the shore line. The volume of this eight feet of storage was estimated at 160,000 acre feet, based on the area of the lake as indicated on the one inch to the mile scale maps. The surface area of the lake is hard to determine because of its great spread during high water. It is believed that this volume is a conservative estimate and that together with intermediate regulation it would guarantee a minimum flow throughout the year of over 1,000 c.f.s.

Field surveys, reconnaissance and investigations will be required before contract design plans are prepared. The irrigation project together with the hydroelectric project downstream will provide initial requirements for an over-all economic development of the Yawnghwe Valley.

C. ESTIMATE OF COSTS AND BENEFITS

The economic feasibility of any development is dependent on the benefits that may be derived therefrom. Estimated benefits are balanced against the estimated cost of the works including interest and amortization. The total estimate of cost, annual benefits, annual charges and ratio of cost to benefits for the first 12 projects listed in Table IX–4 of this report are shown in Table IX–19 (*see p.* 243). The Mu River irrigation project and the Yamethin District irrigation project are sub-divided into project stages and the data shown for each division. The land area in gross acres to be served under each development is also shown.

1. ESTIMATE OF COST

All cost estimating is based on materials and material quantities derived from preliminary designs and suggestive structure details. Unit costs are based on known unit price bids for similar items, on the assumption that the construction will be done by or under experienced contractors and in accordance with recognized good engineering and construction practice. Reinforcing and structural steel, gates, pipe and equipment, and on some projects, contractors' overhead and profit, are considered as foreign expenditures.

The costing does not include the distribution system for individual farm or ownership services. This part of the irrigation system exists in most places at this time and will require only revision and improvement. The nature of the present farm plot layout makes the development of a complete new distribution system impractical. This may be done later as the farm methods are improved. A nominal amount has been included in the estimate for initial improvements in the existing distribution system and farm plot layout.

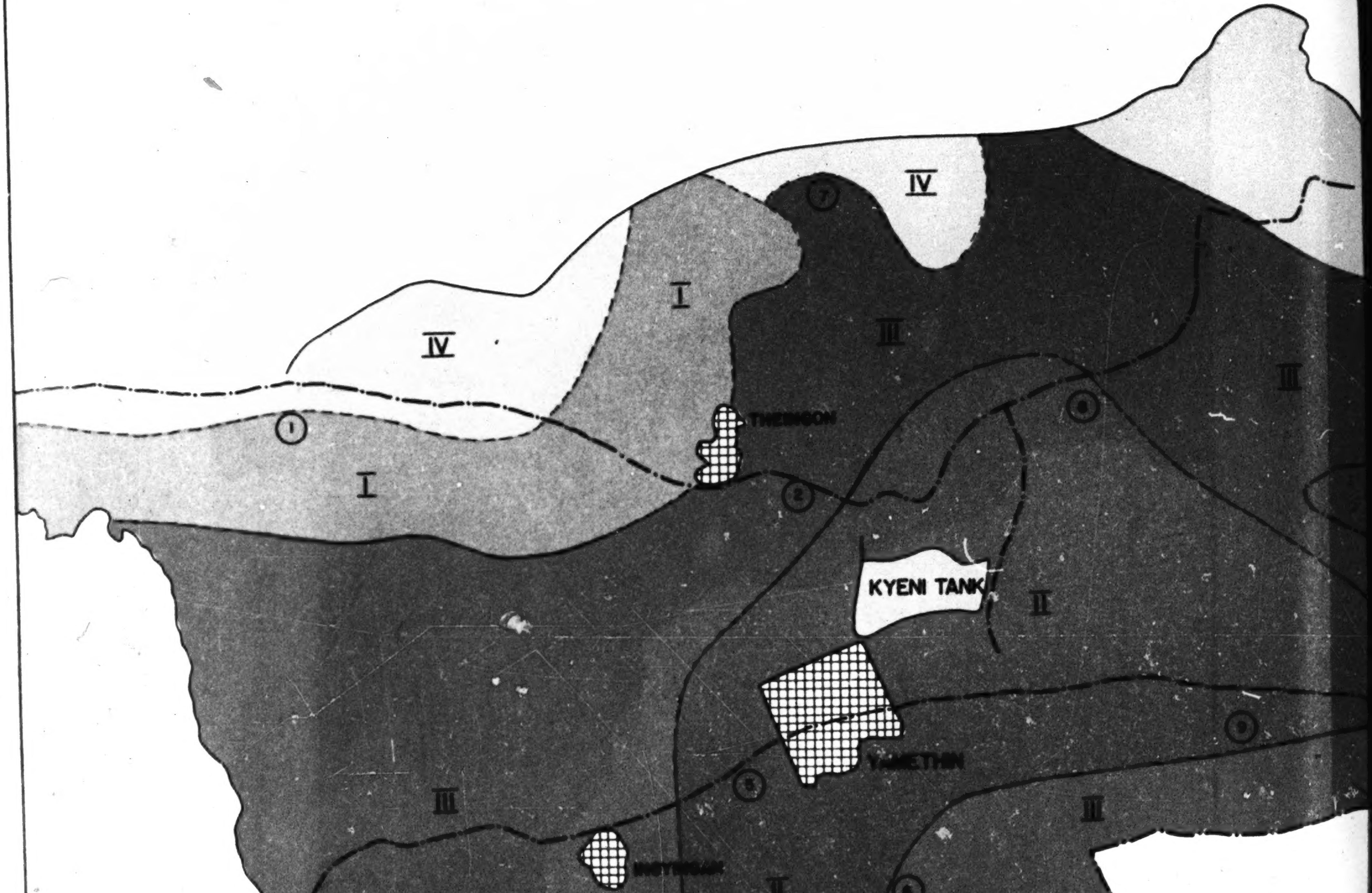
Engineering includes design and construction, plans, specifications and supervision, field surveys and topographic mapping, investigations, technical assistance, construction engineering and inspection. Foreign expenditures are assumed for the design and construction plans, specifications and supervision as specified for project units in Table IX–20 (*see p.* 246), topographic mapping and technical assistance for investigations, and local designing, plan preparation and supervision. All field surveys required for the design and preparation of plans and the construction engineering staff are assumed as local expenditures.

2. BENEFITS

The benefits are direct returns from crop production resulting from the facilities of the project. These are net income benefits over and above present production using records of acreage shown and yield for each crop for a five-year period ending June, 1940. Indirect benefits such as increased transportation, local business, labor opportunities, and living conditions will result from a project development, but these have not been included.

Benefits from two classifications of cultivation methods have been estimated and are shown in Table IX–19. These classifications were described in Section A-3-c of this chapter. The benefit to the farmer from production is the increased crop production value over present income including farm operation costs. The benefit to the Government is the profit to SAMB from increased rice exports due to the increased production, and the decreases in imports or increase in exports of certain crops because of the increases of production of those crops. The values shown are ultimate maximum benefits for both classifications of cultivation methods.

Present production is based on the data contained in the report "An Economic Classification of Land in Burma" by J. T. Sanders and U Ba Tin. The percentage of acreage shown therein as matured for each district is used in this computation for each of the project units. Production under "Present Methods" with irrigation assumes all the net acreage under a project as producing one crop per year. This represents an increase in matured acres of from 20% to 30% over the present and is part of the benefits from the project. Other benefits are those from increase in yield from controlled water. Benefits under "Modern Methods" are from increased yields because of sufficient water, fertilizer where practical, improved seeds, crop rotation and improved cultivation methods, and a full double crop program. All increased rice production is assumed as exported in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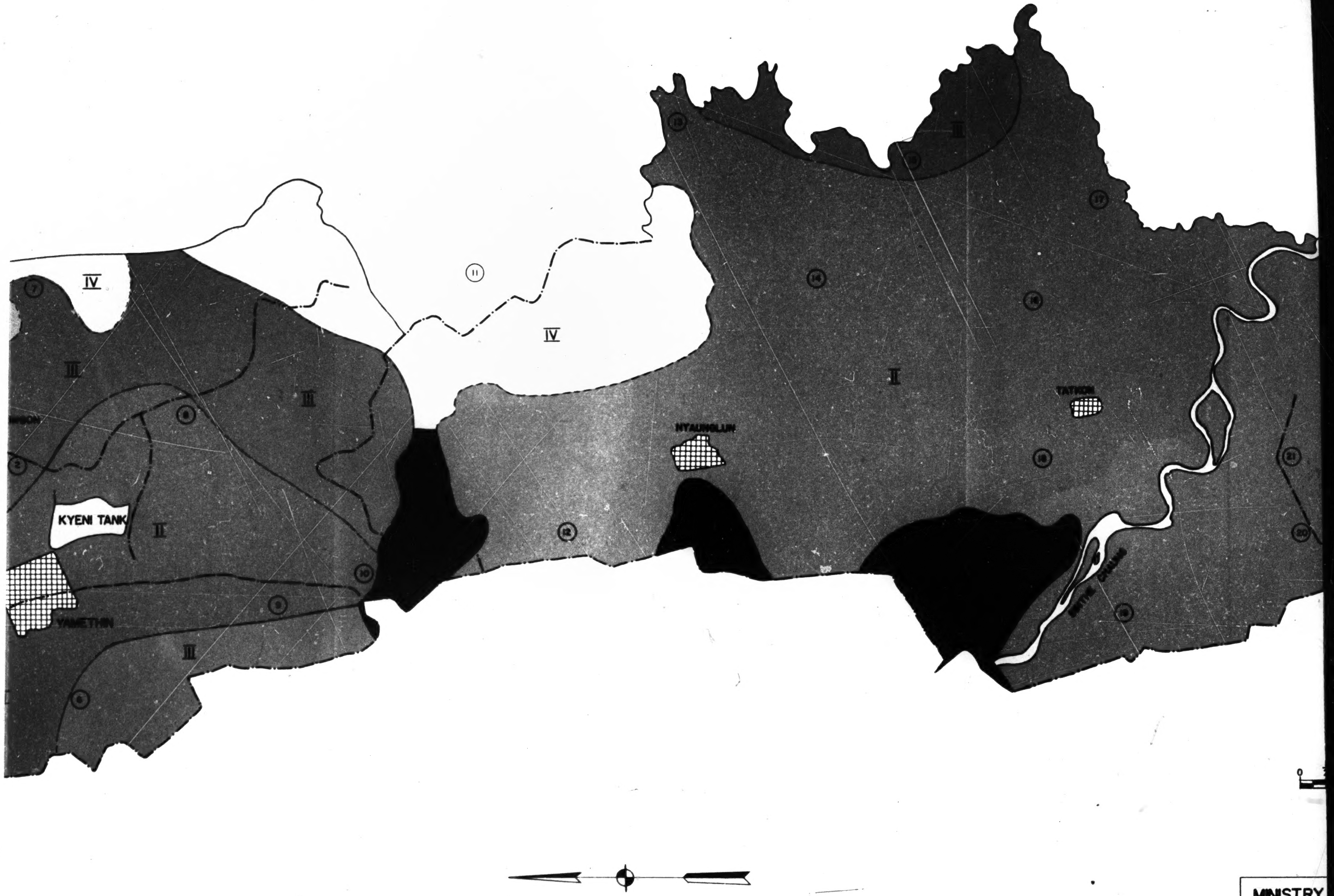
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YAMETHIN
NYAUNGLUN
TATKON
SINTHE CHAUNG

MINISTRY

YAMETHIN

KNAPPEN TIP
NEW YORK
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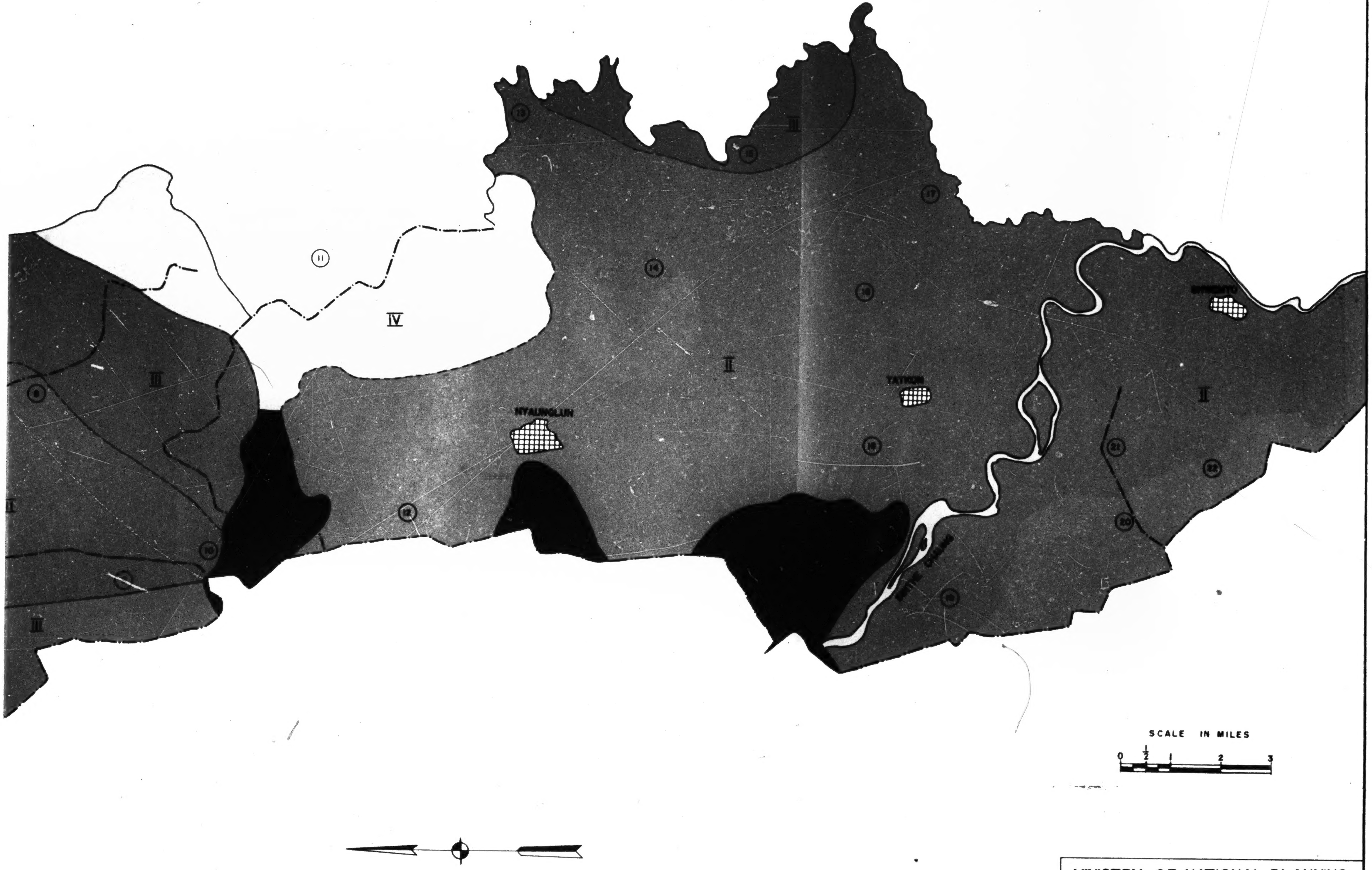
CK. BY: H.S.N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MINISTRY OF NATIONAL PLANNING

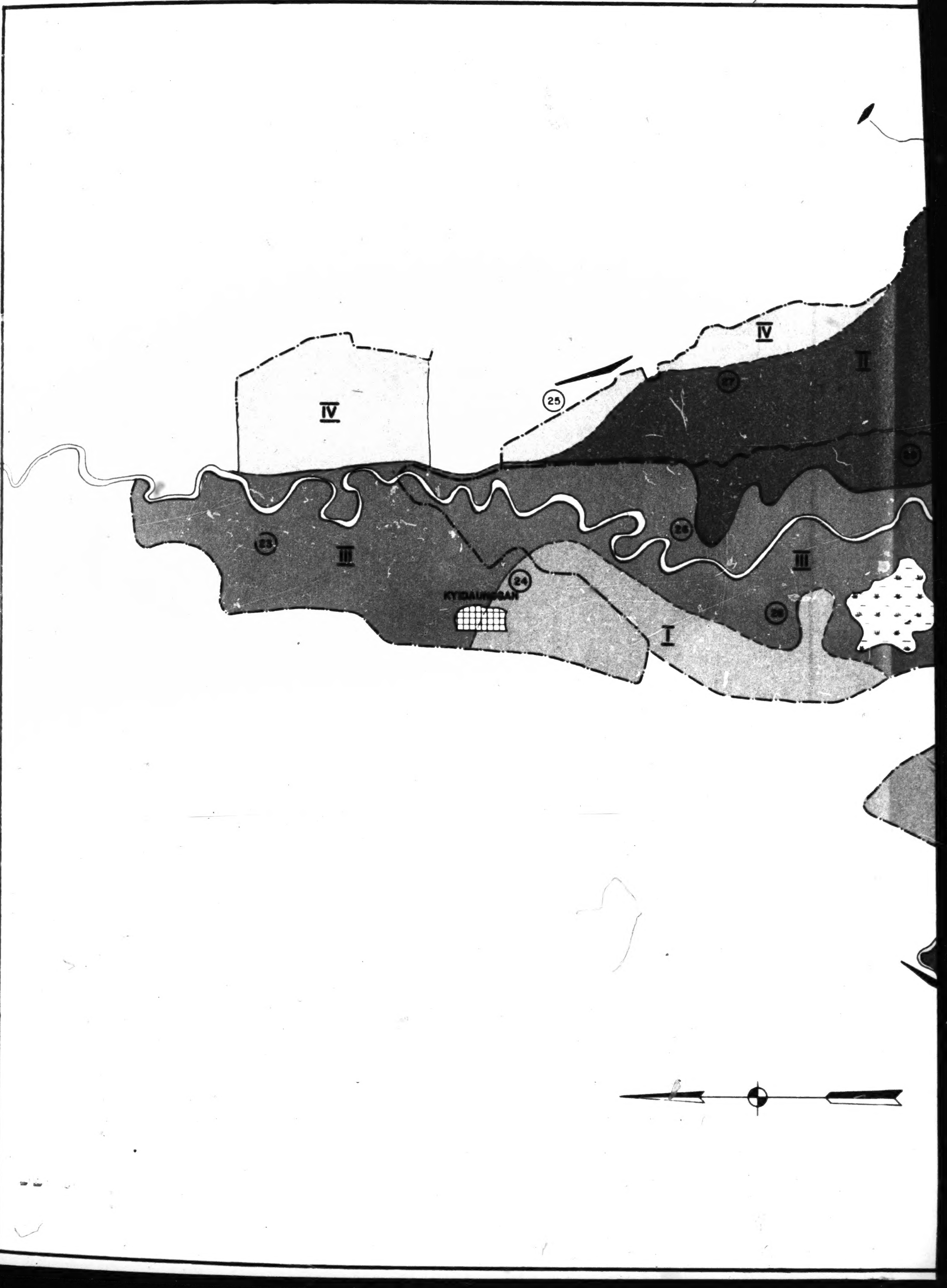
YAMETHIN DISTRICT IRRIGATION PROJECT

SOIL MAP

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON

DR. BY: E. J. P. DATE
CK. BY: H. S. N.

PLATE NO. 28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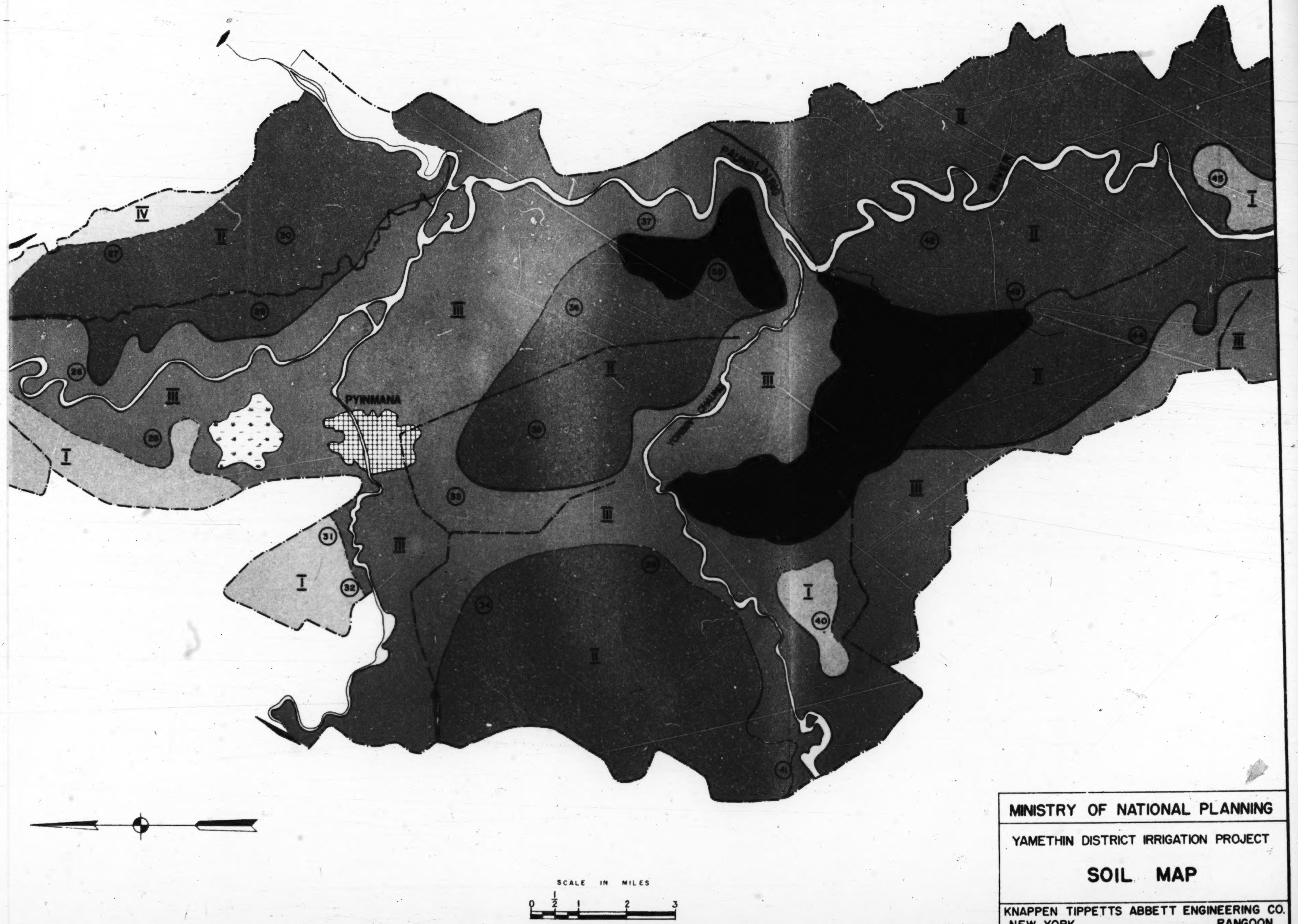
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PAUNGLAUNG
RIVER
YONBIN CHAUNG
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44
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SCALE IN MILES
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2
3

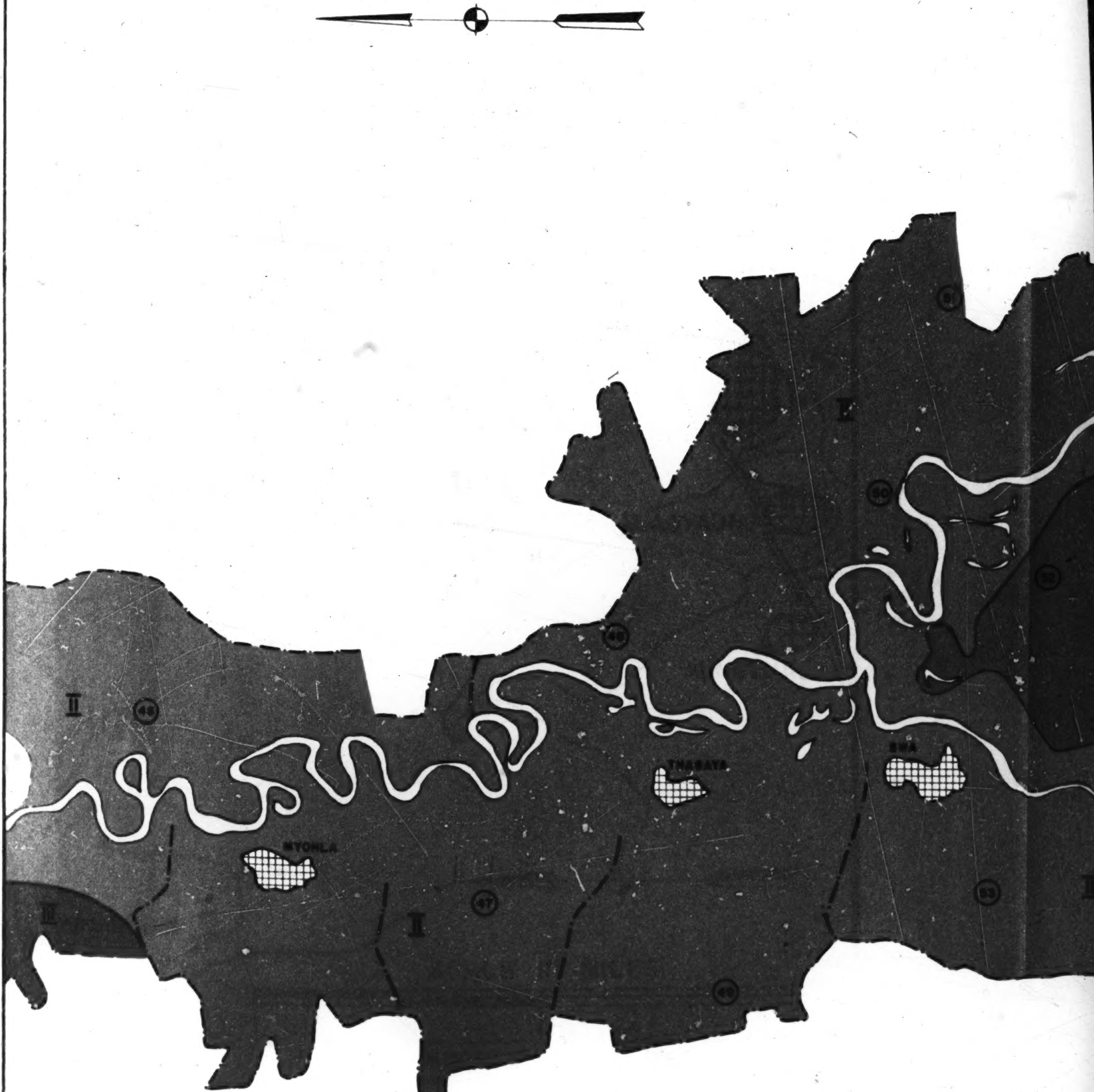
MINISTRY OF NATIONAL PLANNING

YAMETHIN DISTRICT IRRIGATION PROJECT

SOIL MAP

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P. DATE PLATE
CK. BY H.S.N. JULY 53 NO. 29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THASAYA
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SWA
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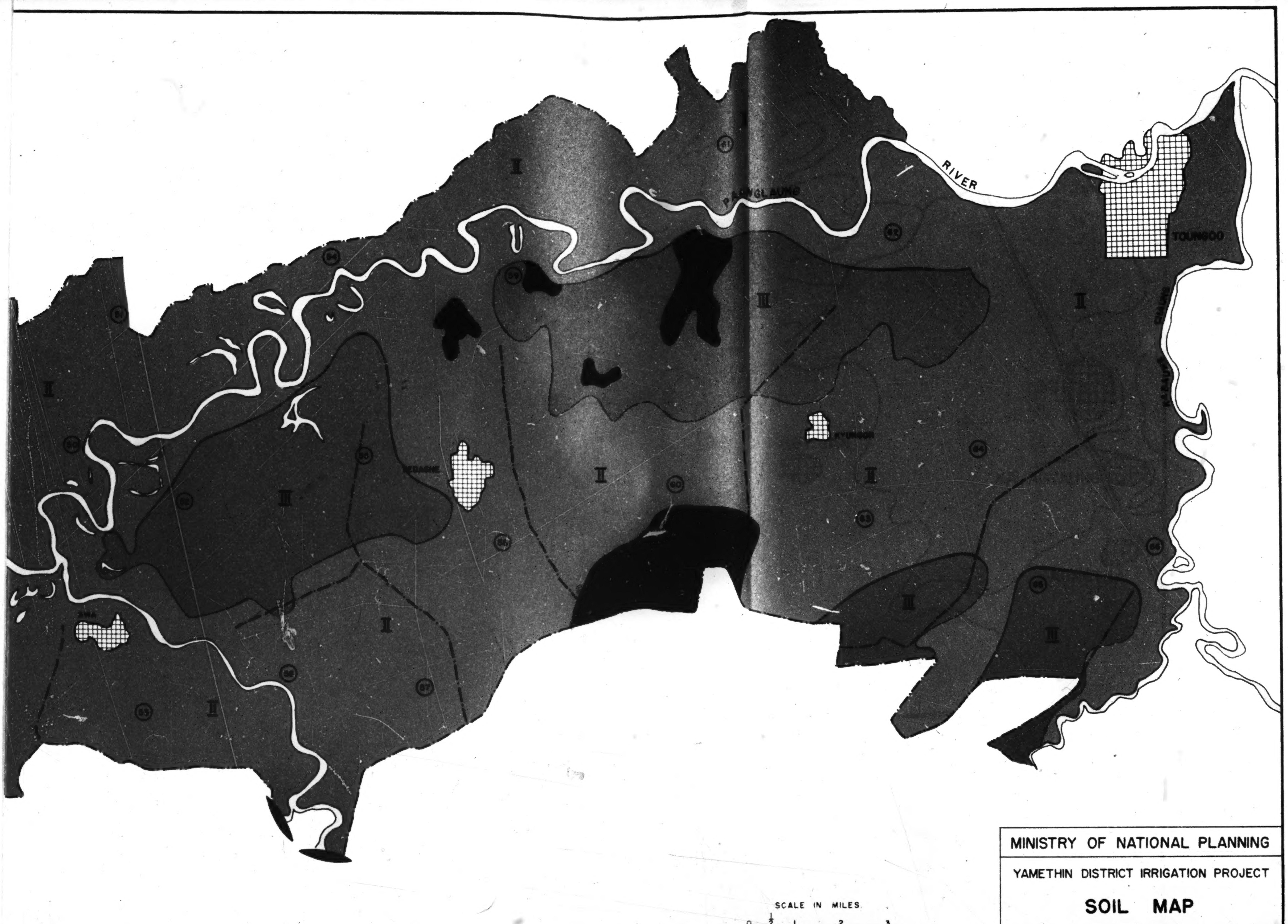
RIVER
PAUNGLAUNG
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KABAUNG CHAUNG
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SCALE IN MILES
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MINISTRY OF NATIONAL PLANNING

YAMETHIN DISTRICT IRRIGATION PROJECT

SOIL MAP

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

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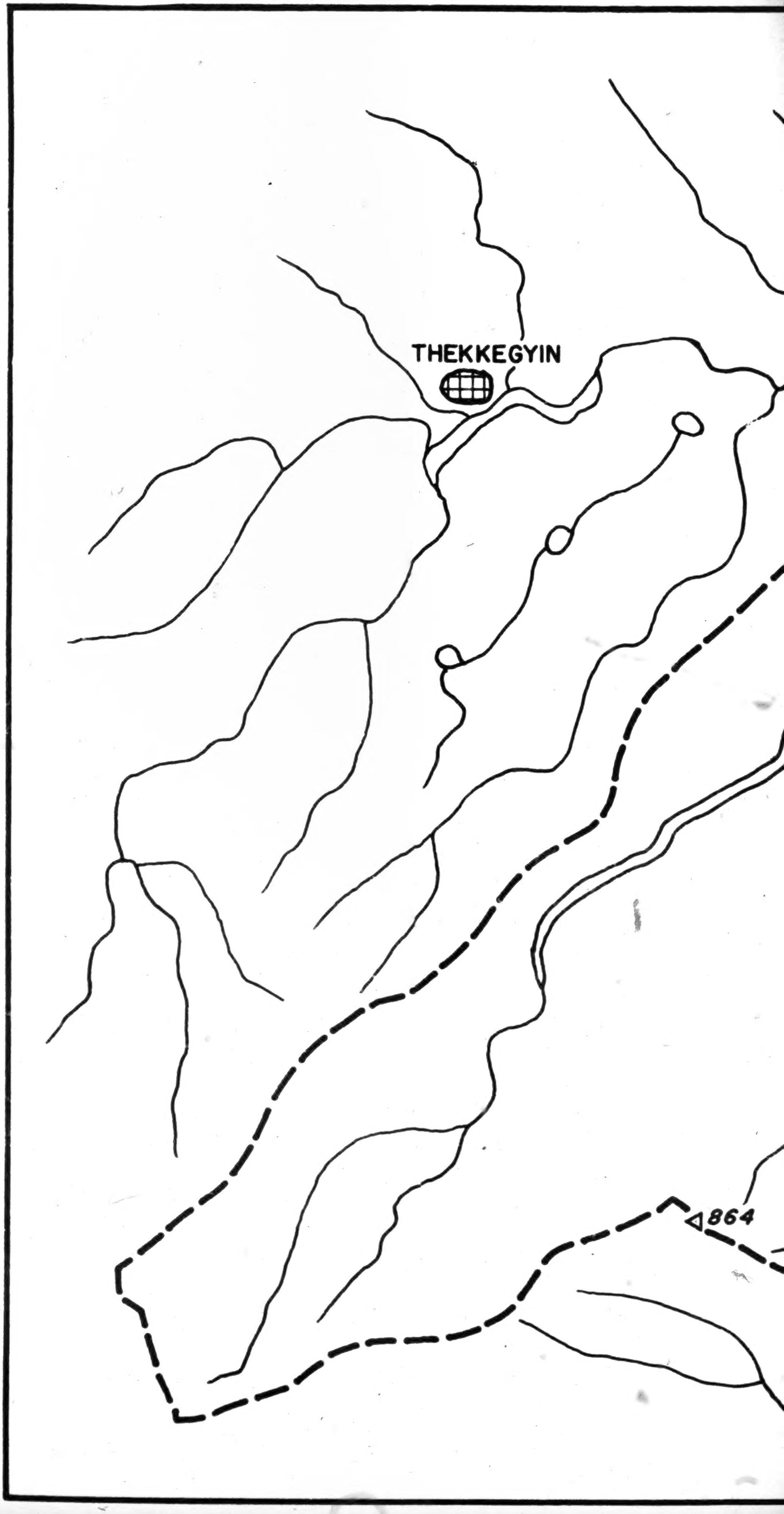
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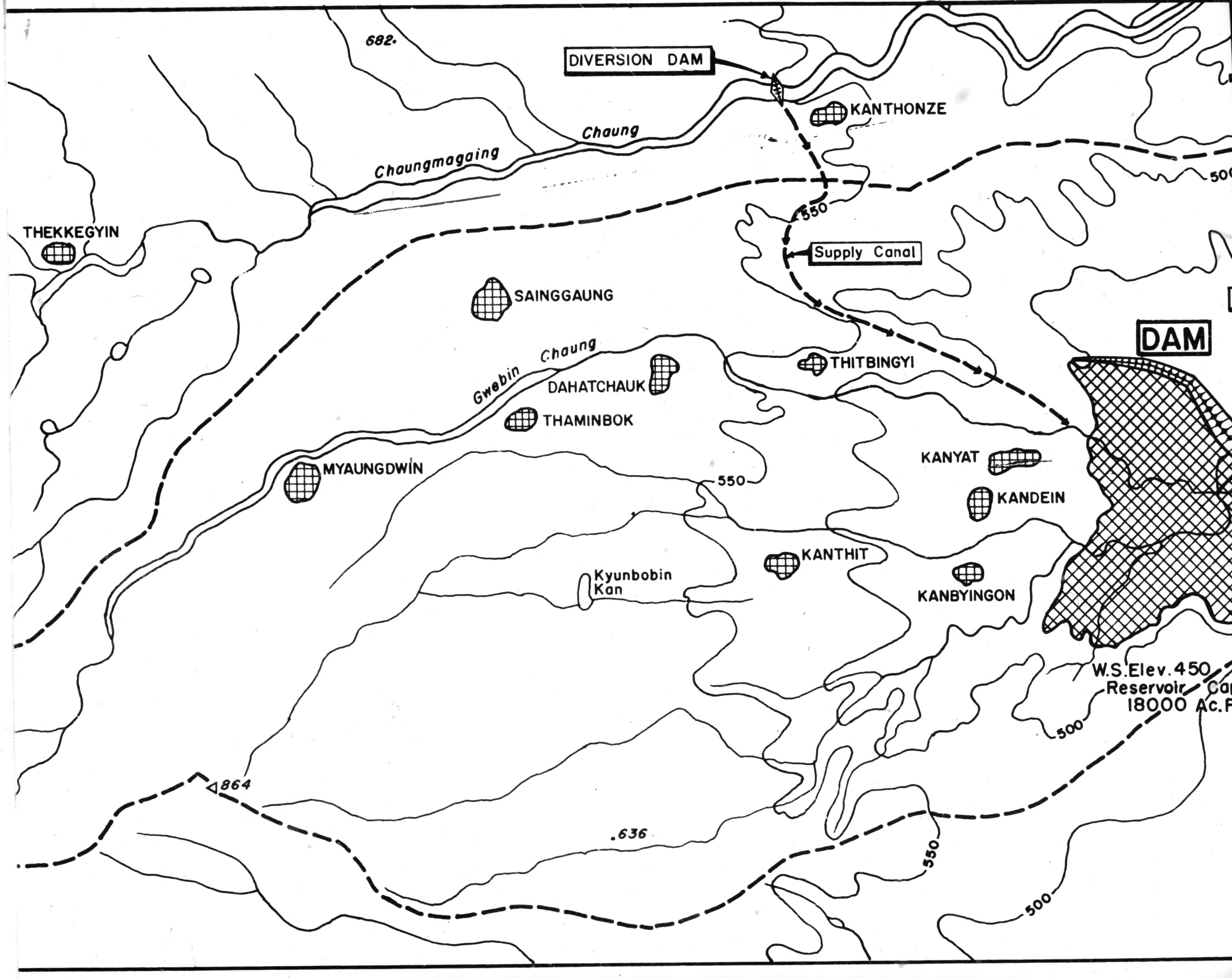
682.
DIVERSION DAM
KANTHONZE
Chaung
Chaungmagaing
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Supply Canal
THEKKEGYIN
SAINGGAUNG
DAM
Gwebin Chaung
THITBINGYI
DAHATCHAUK
THAMINBOK
MYAUNGDWIN
550
KANYAT
KANDEIN
KANTHIT
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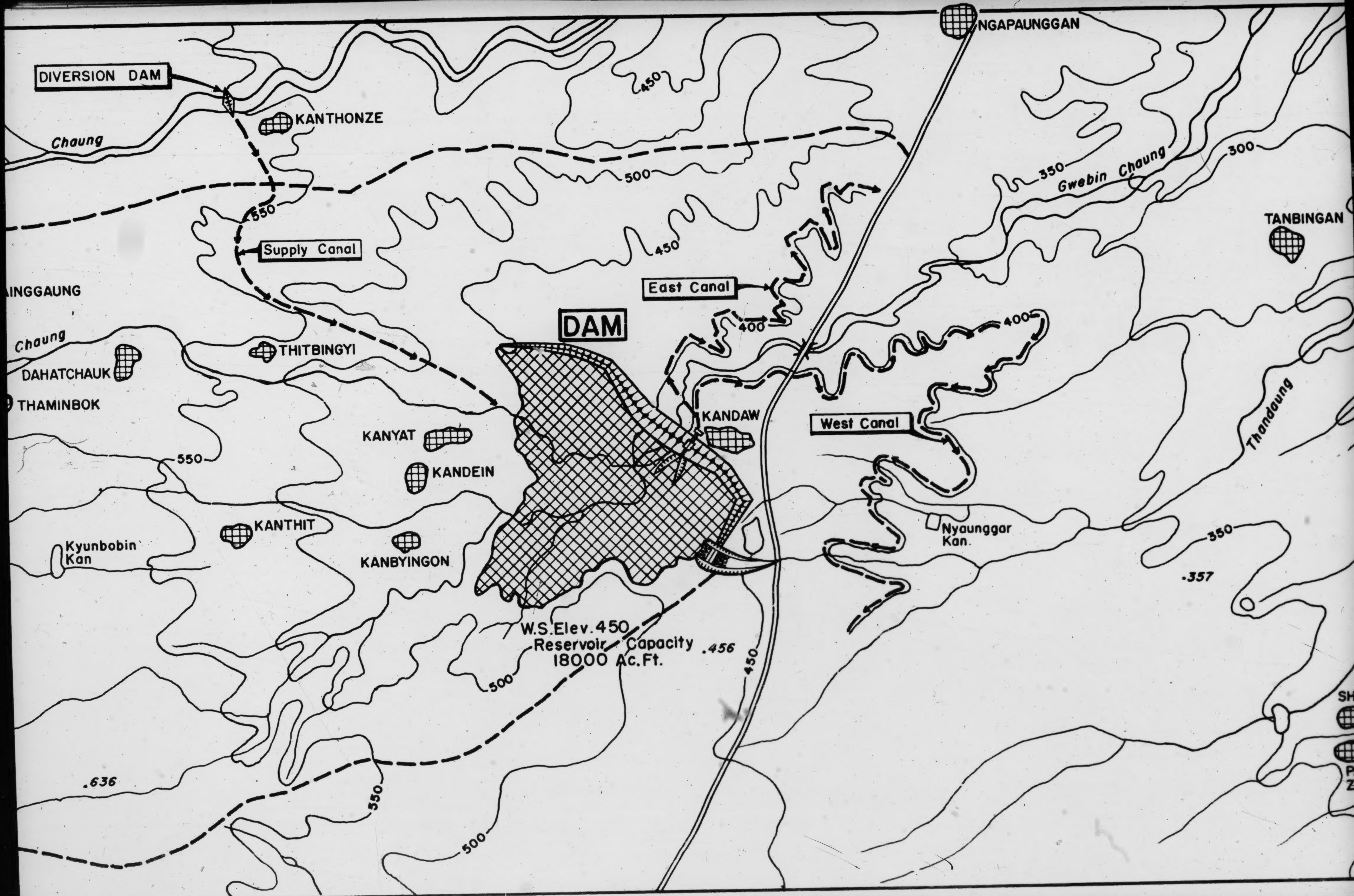
DIVERSION DAM
KANTHONZE
Chaung
450
500
550
Supply Canal
450
East Canal
DAM
400
400
NGAPAUNGGAN
350
Gwebin Chaung
300
TANBINGAN
INGGAUNG
Chaung
THITBINGYI
DAHATCHAUK
THAMINBOK
KANYAT
KANDEIN
KANDAW
West Canal
Thandaung
550
KANTHIT
Kyunbobin Kan
KANBYINGON
Nyaunggar Kan.
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18000 Ac.Ft.
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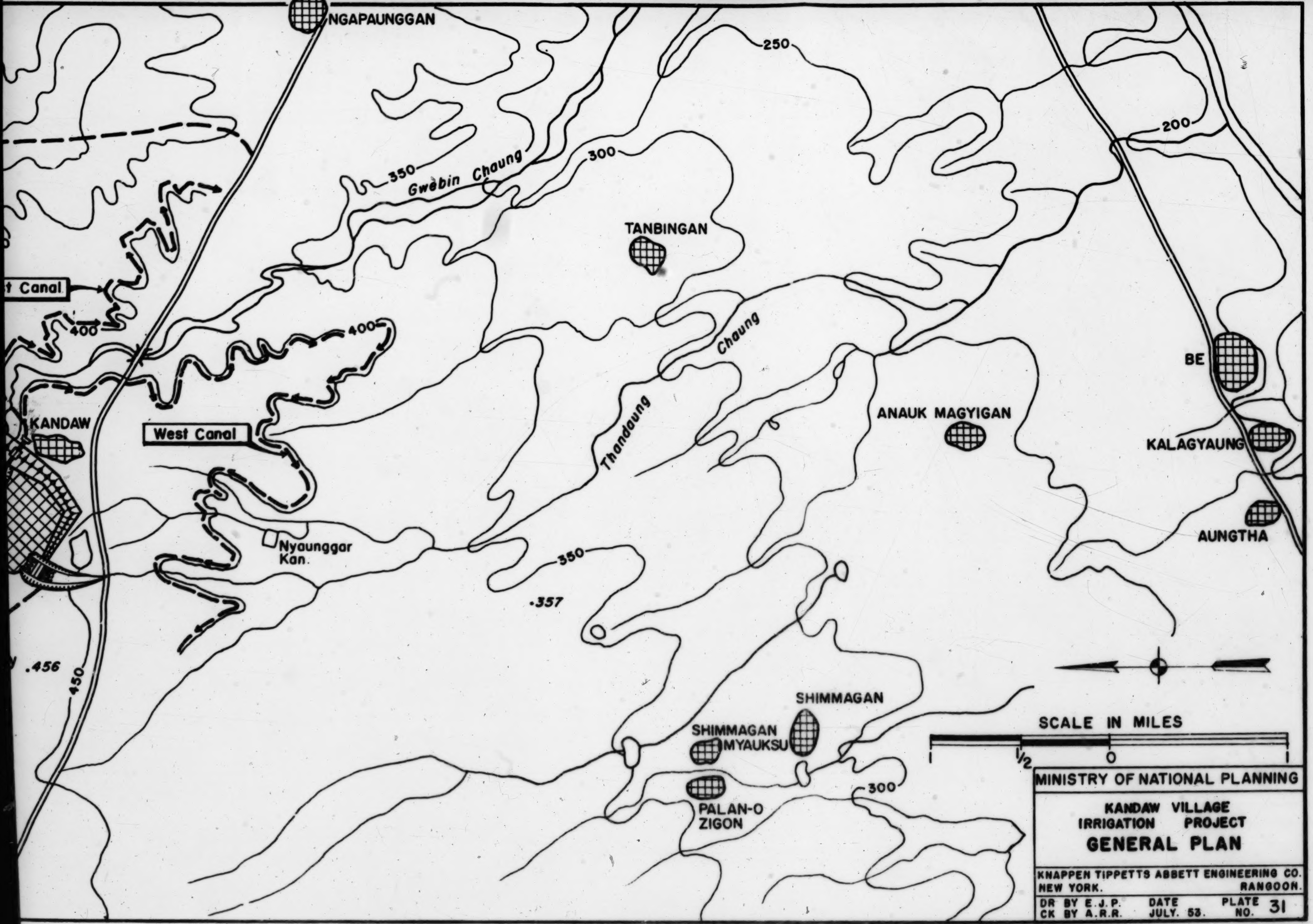
NGAPAUNGGAN
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Gwebin Chaung
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ANAUK MAGYIGAN
KALAGYAUNG
AUNGTHA
Nyaunggar Kan.
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SHIMMAGAN
SHIMMAGAN MYAUKSU
PALAN-O ZIGON
300
SCALE IN MILES
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MINISTRY OF NATIONAL PLANNING

KANDAW VILLAGE
IRRIGATION PROJECT
GENERAL PLAN

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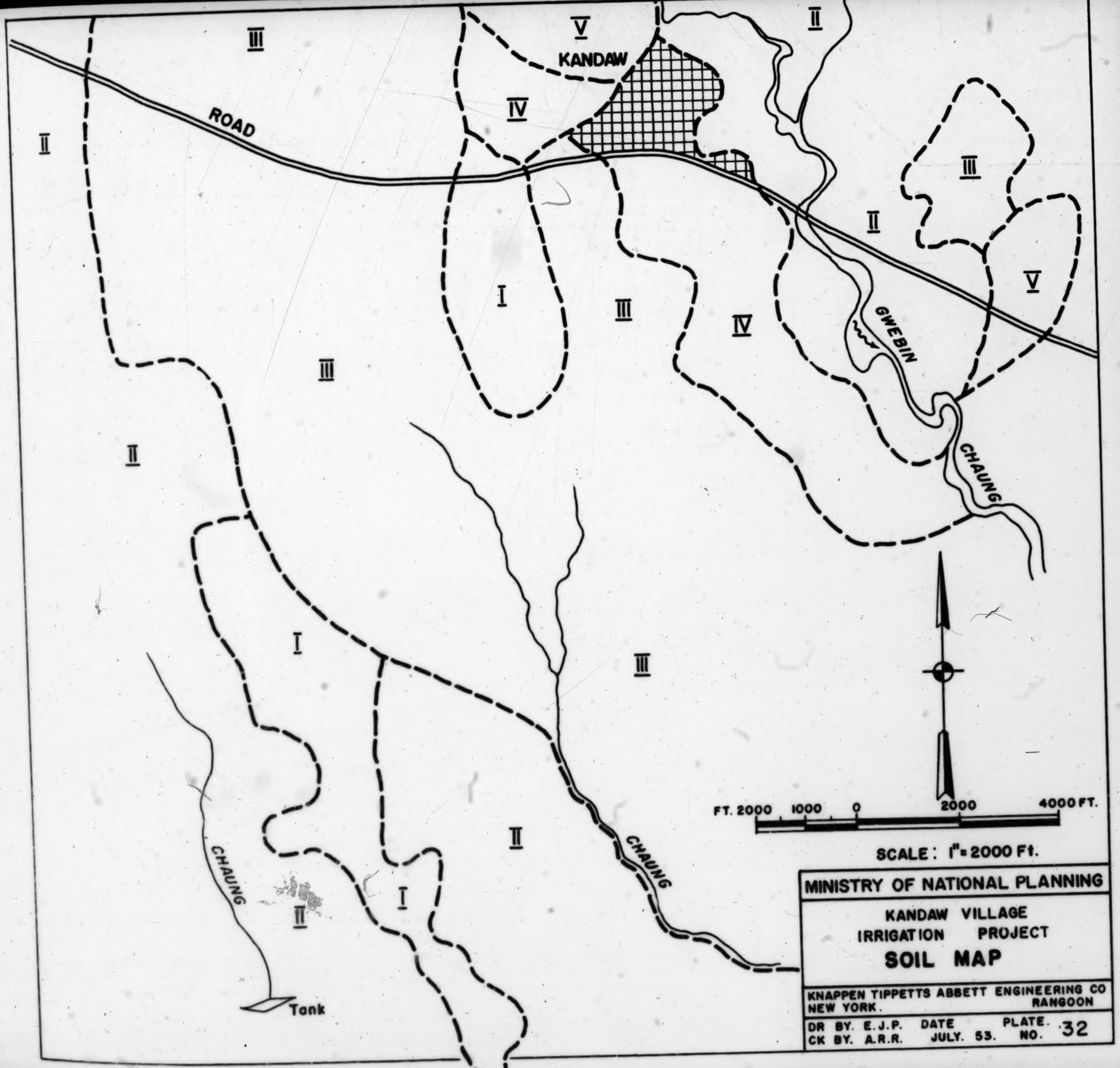
III
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SCALE: 1" = 2000 Ft.

MINISTRY OF NATIONAL PLANNING

KANDAW VILLAGE
IRRIGATION PROJECT
SOIL MAP

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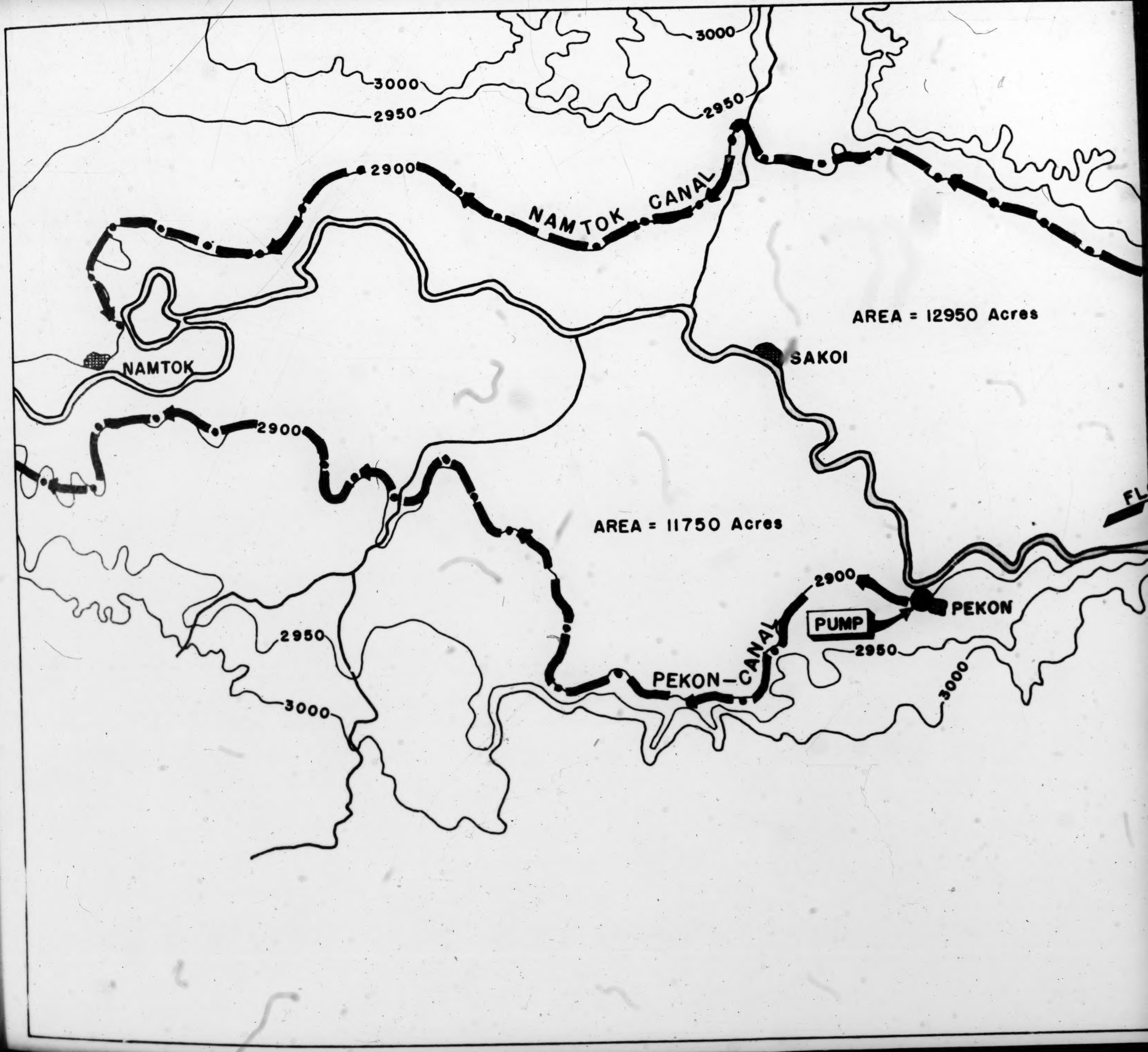
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NAMTOK CANAL
NAMTOK
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AREA = 12950 Acres
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AREA = 11750 Acres
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PEKON-CANAL
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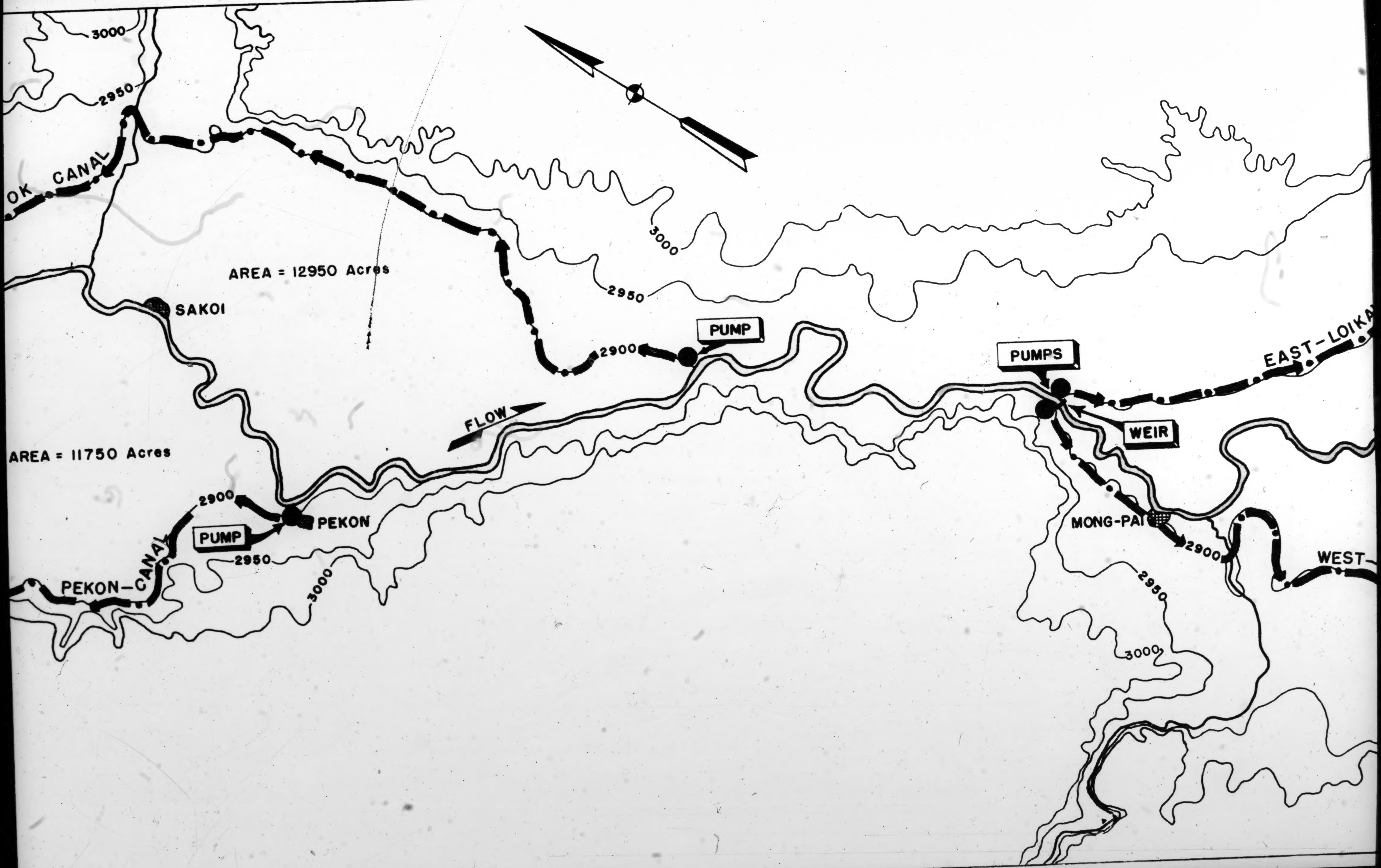
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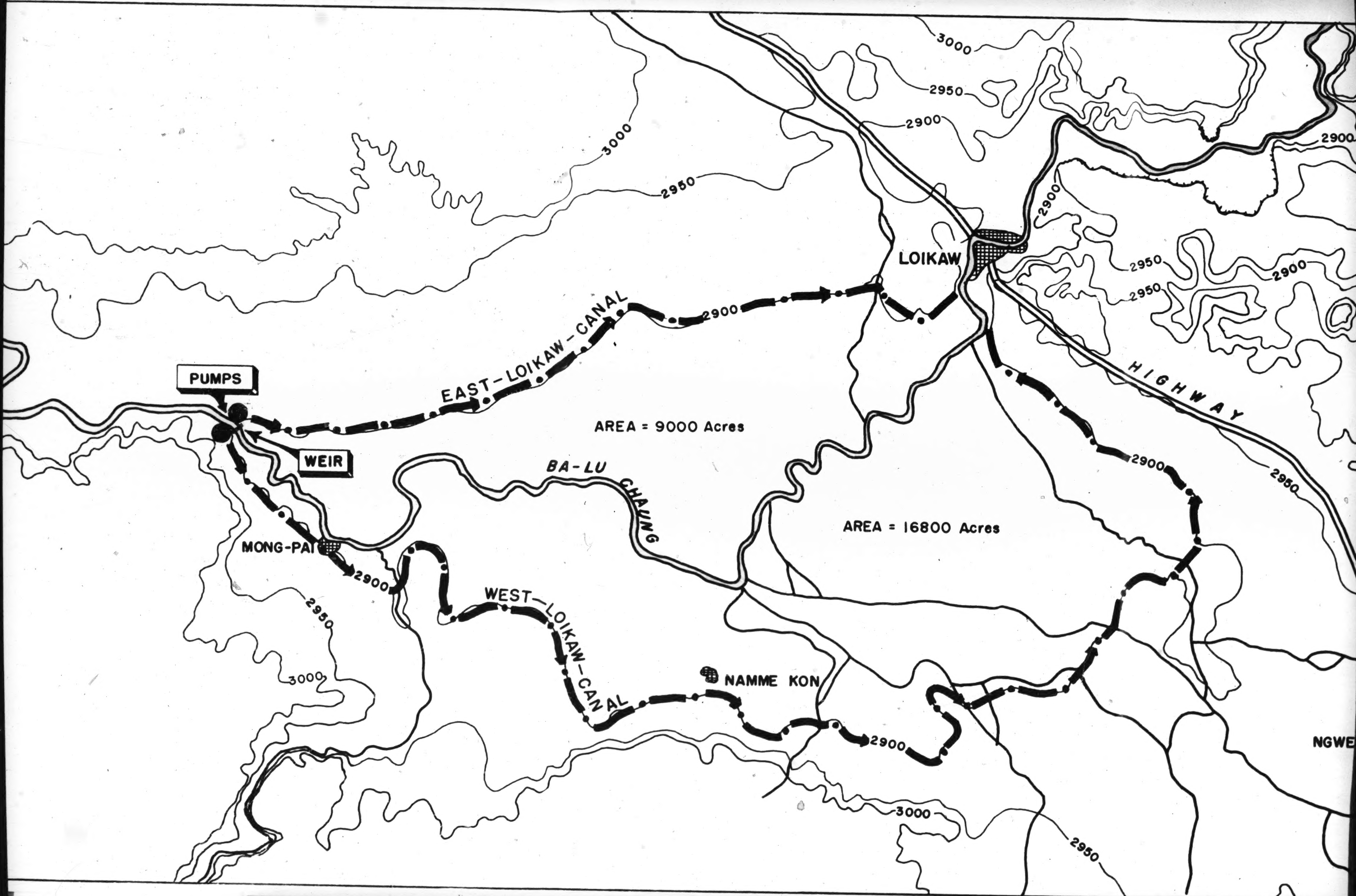
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LOIKAW
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HIGHWAY
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PUMPS
WEIR
AREA = 9000 Acres
BA-LU CHAUNG
2900
2950
AREA = 16800 Acres
MONG-PAI
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WEST-LOIKAW-CANAL
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NAMME KON
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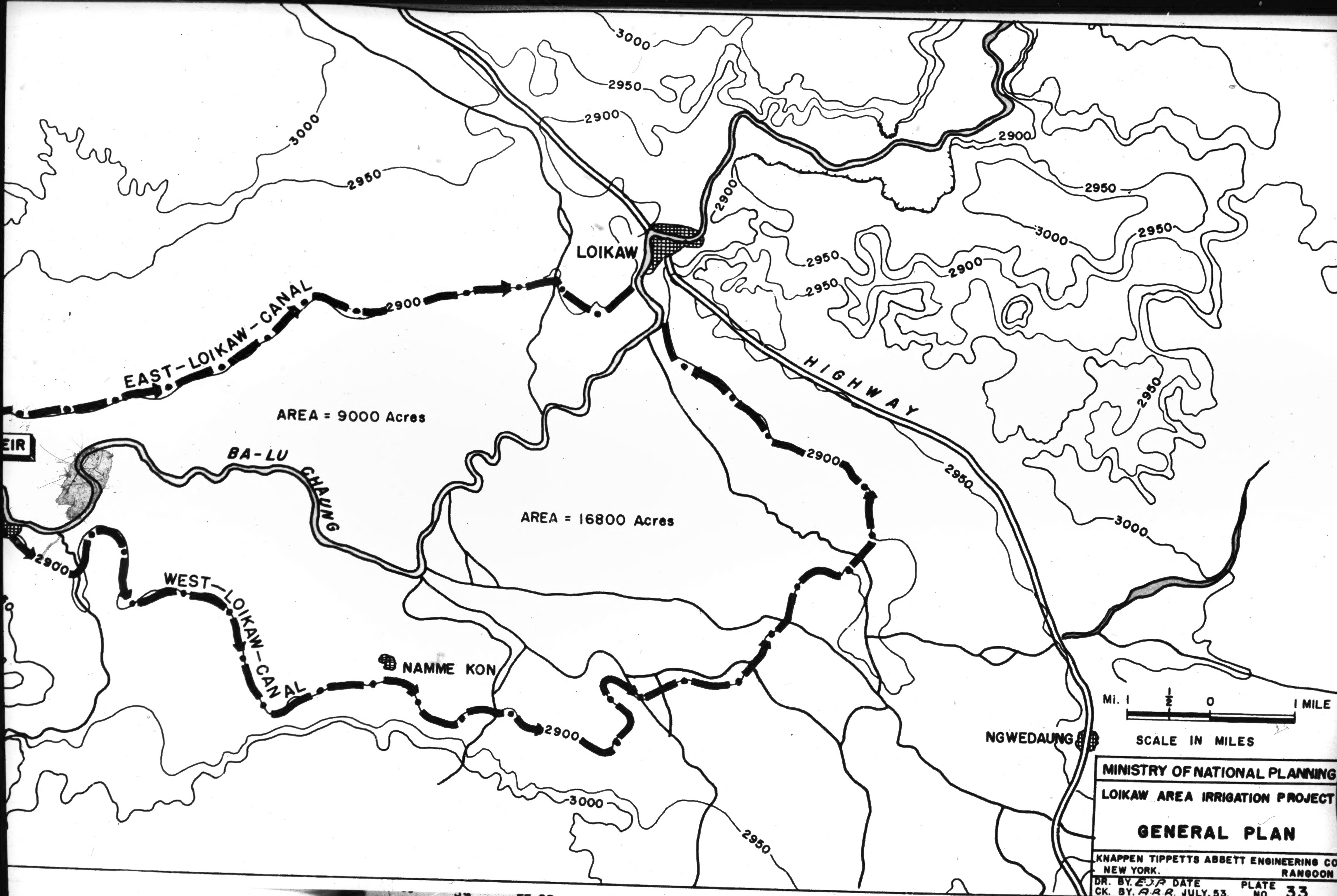
3000
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LOIKAW
EAST-LOIKAW-CANAL
2900
HIGHWAY
AREA = 9000 Acres
EIR
BA-LU
CHAUNG
2900
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AREA = 16800 Acres
3000
2900
WEST-LOIKAW-CANAL
NAMME KON
2900
NGWEDAUNG
Mi. 1 ½ 0 1 MILE
SCALE IN MILES
3000
2950

MINISTRY OF NATIONAL PLANNING

LOIKAW AREA IRRIGATION PROJECT

GENERAL PLAN

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK. RANGOON

DR. BY. E.J.R. DATE
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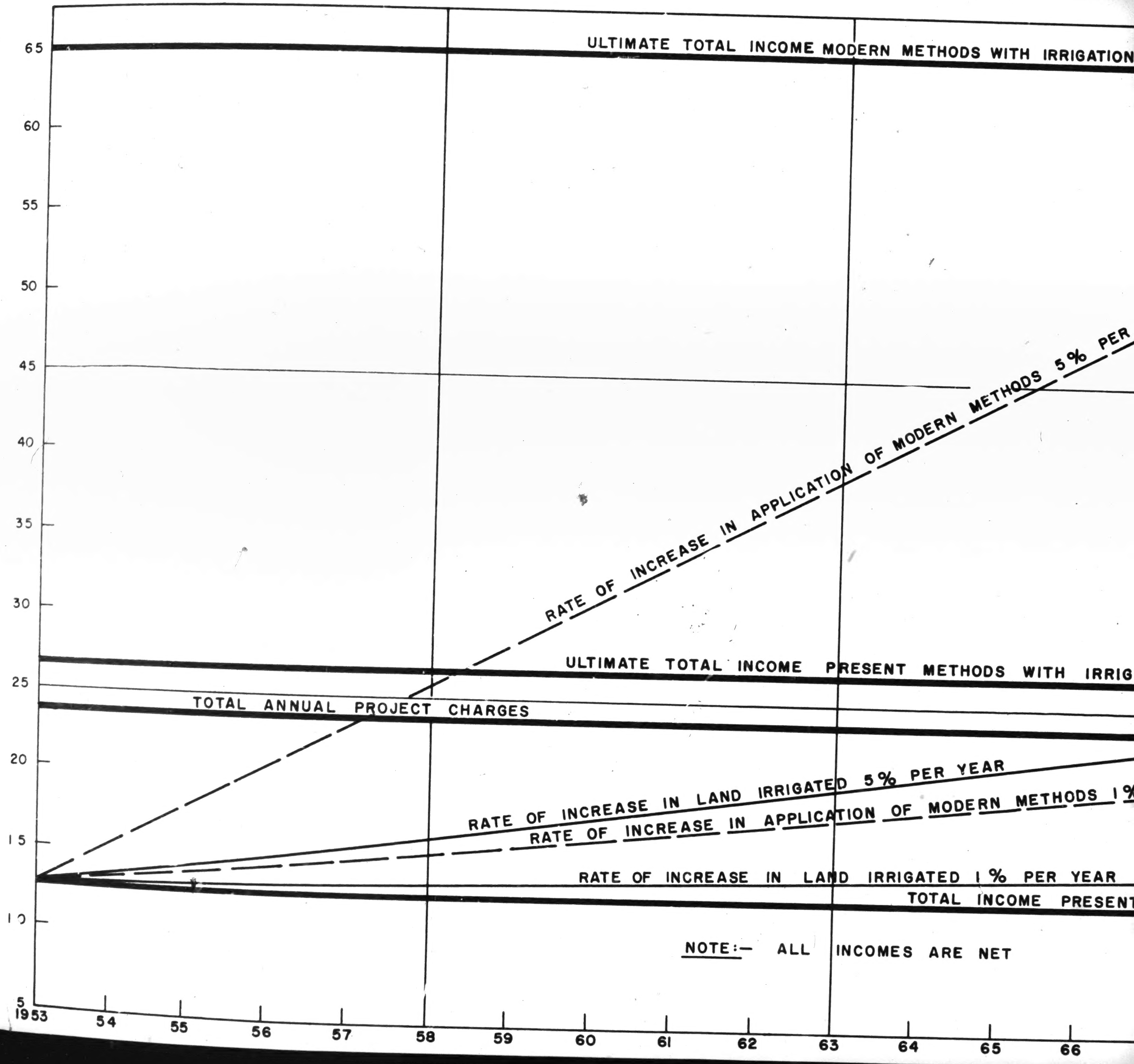
ULTIMATE TOTAL INCOME MODERN METHODS WITH IRRIGATION
RATE OF INCREASE IN APPLICATION OF MODERN METHODS 5% PER
ULTIMATE TOTAL INCOME PRESENT METHODS WITH IRRIG
TOTAL ANNUAL PROJECT CHARGES
RATE OF INCREASE IN LAND IRRIGATED 5% PER YEAR
RATE OF INCREASE IN APPLICATION OF MODERN METHODS 1%
RATE OF INCREASE IN LAND IRRIGATED 1% PER YEAR
TOTAL INCOME PRESENT
NOTE:— ALL INCOMES ARE NET
65
60
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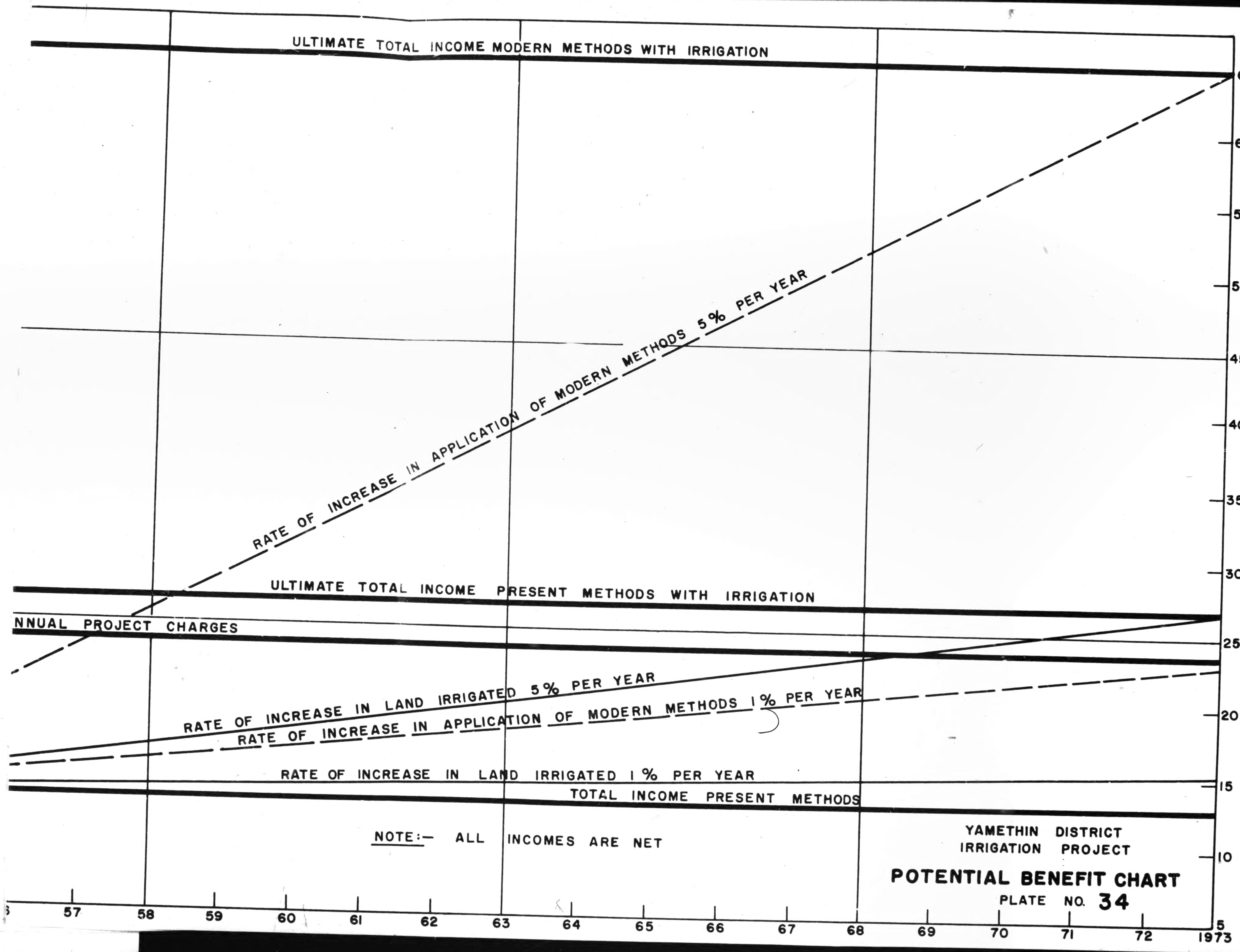

YAMETHIN DISTRICT
IRRIGATION PROJECT

POTENTIAL BENEFIT CHART

PLATE NO. **34**

addition to the present exports. Increased production in groundnuts and sesamum is also a benefit to the nation because of its effect on imports of these products. Areas presently high in rice acreage will show higher benefits because of the increases in exports of that product.

Benefits for different rates of development for both classifications of cultivation using the Yamethin District irrigation project as a model are shown in Plate 34, together with the present total net production income and the potential production incomes from both classifications. The total annual charges for the project are also indicated. The chart graphically shows the rate of development necessary for production to balance the annual charges and the total potential benefits that are possible from the land. The chart is prepared for one project only, but is typical for all those recommended. The potential benefits on other projects may be even greater.

3. ANNUAL CHARGES

The annual charges shown in Table IX-19 are cost of power for pumping, operation and maintenance of the project system, and interest and amortization of the investment. These individual charges were computed as follows:

Interest

Local money expenditures	4%
Foreign money expenditures ..	5%

Amortization—Same rate of interest
- 50-year life on all units of the project except pump equipment
- 25-year life on all pump equipment

Operation and Maintenance

Dams and embankments ..	1% of cost
Structures and canals ..	5% of cost
Power for pumping	Pyas 15 per kWh

The long life assumed for gates and equipment other than pumping is believed feasible because of the high operation and maintenance. The short life assumed for the dam and embankments resulted from the heavy silt content of the streams. The initial power costs will be high but as the power demand increases so that the hydroelectric installations operate at greater capacity, power costs will decrease materially.

4. RATIO COST TO BENEFITS

The ratio of cost to benefits in Table IX-19 is net benefits annually as against total annual charges. Ratios for both classifications of cultivation methods are shown. These ratios clearly indicate the projects most feasible for development from the standpoint of economics. Indirect benefits have not been included in this Report because all projects are considered as being equal in this respect.

Ratios of cost to benefits for the "Storage Reservoir and Dam" and "West Side Canal System" under the Mu River irrigation project are higher than other units of the project. This is because the benefits for the storage reservoir and dam are from the Shwebo and Ye-U systems which are constructed and in operation and are not charged against the project; and the "West Side Canal System" charges contain no costs of the storage reservoir and dam.

The Yezin system, Paunglaung River supply and Paunglaung River pumping units of the Yamethin District irrigation project are made possible by water from the Paunglaung River development. Therefore the annual charges on a portion of the Paunglaung River dam and reservoir capital cost are allocated to these units of the project. The amount of the annual charges is based on K95,00,000 which is the portion of the total cost of the hydroelectric development estimated as contributing to irrigation benefits. These annual charges are included in the total charges against the project units for computing the benefit-to-cost ratio. The Paunglaung River hydroelectric project discussion in Chapter XIX includes the total estimate of cost for the dam and reservoir, but shows this credit in computing the estimated cost of power. None of the capital cost is included in the Yamethin District irrigation project units, Table IX-19.

D. RECOMMENDATIONS

1. CONTINUATION OF PROJECT STUDIES

The studies and details used in the preparation of the projects presented in this Report are incomplete. Sufficient data were available only for preliminary planning to determine economic and physical feasibility of a particular development. Detailed field surveys are necessary for exact location of project units and for preparation of contract design plans.

It is recommended:

a. Surveys

That field explorations and surveys for dam locations and topography, reservoir capacity and area, canal locations, and structure site topography proceed as rapidly as possible on all those projects selected for "Early Implementation"; that procedure be in accordance with the schedule of priority and selection of the project units; and that the work be performed by either the Department of Irrigation personnel or parties selected for the purpose, all under the supervision and direction of the Ministry of National Planning.

TABLE

ESTIMATED CAPITAL COST,

1	2	3	4	5
	Proposed Development			
		Estimated Cost (K)		
Project	*Gross Acres*	*Works*	*Engineering*	*Total*
Mu River Irrigation				
Storage Reservoir and Dam	—	3,86,09,700	48,01,300	4,34,11,000
Diversion Dam and Old Mu Canal	151,831	3,90,94,150	40,43,850	4,31,38,000
West Side Canal System	539,408	4,21,78,000	38,05,000	4,59,83,000
Chindwin River Pumping	166,400	1,89,34,000	31,53,000	2,20,87,000
Irrawaddy River Pumping	122,500	1,57,62,300	25,76,700	1,83,39,000
Seikpyu Installation	19,250	17,94,200	3,97,800	21,92,000
Total	999,389	15,63,72,350	1,87,77,650	17,51,50,000
Yamethin District Irrigation				
Sinthe Chaung Development—Gravity	22,600	3,57,80,700	51,73,300	4,09,54,000
Sinthe Chaung above Pump and Kyeni Tank	88,100	1,34,30,500	19,45,500	1,53,76,000
Thitson Chaung Development	32,500	1,95,89,400	28,31,600	2,24,21,000
Well Pump Irrigation	73,500	1,33,34,200	20,34,800	1,53,69,000
Yezin Chaung Development	20,780	1,93,80,100	27,38,900	2,21,19,000
Yezin System—Paunglaung River Supply	35,470	78,95,500	14,55,500	93,51,000
Paunglaung River Pumping	72,240	1,28,91,600	19,63,400	1,48,55,000
Ngalaik Chaung Development	94,360	3,20,21,400	46,42,600	3,66,64,000
Swa and Saing Chaungs Development	169,900	7,38,51,500	1,04,30,500	8,42,82,000
Total	609,450	22,81,74,900	3,32,16,100	26,13,91,000
Kandaw Village Irrigation	15,600	67,29,710	8,15,290	75,45,000
Loikaw Area Irrigation	50,500	66,30,100	7,70,900	74,01,000
Meiktila Lake Silt Removal	Not Estimated—Additional study data and investigations required			
Pakokku Pump Irrigation from Wells	‡40	21,600	2,400	§24,000
Lower Delta Pump Irrigation				
Thongwa Island	~~70,~~000	1,23,70,600	6,18,400	1,29,89,000
Yandoon Island	157,000	2,20,56,000	11,03,000	2,31,59,000
Henzada-Zalun	300,000	3,06,07,000	15,31,000	3,21,38,000
Maubin Island	121,000	1,38,99,000	6,95,000	1,45,94,000
Pegu Area	40,000	98,36,000	4,84,000	1,03,20,000
Total	688,000	8,87,68,600	44,31,400	9,32,00,000
Buthidaung Area Pump Irrigation	100,000	75,10,000	7,50,000	82,60,000

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*No allowance has been made for indirect benefits.

†Does not include charges from Paunglaung River development.

‡Gross acres per pump installation.

§Results of field investigations and test wells may reduce this cost.

IX – 19

ANNUAL CHARGES AND BENEFITS

6	7	8	9	10	11	12	13
*Net Annual Benefits** (*K*)		*Annual Charges* (*K*)				*Ratio*	
						Benefit to Cost	
Present Farm Methods	*Modern Farm Methods*	*Operation and Maintenance*	*Power for Pumping*	*Interest and Amortization*	*Total Charges*	*Present Farm Methods*	*Modern Farm Methods*
1,79,38,000	7,87,00,000	10,34,007	—	21,94,666	32,28,673	5·55	24·40
65,90,000	2,90,59,000	13,61,090	—	21,50,670	35,11,760	1·88	8·28
2,15,10,000	8,32,30,000	16,97,758	—	11,25,306	28,23,064	7·62	29·40
60,19,000	1,93,69,000	8,77,890	5,73,760	12,19,640	26,71,290	2·26	7·24
45,46,000	1,41,03,000	7,41,520	2,94,750	10,65,680	21,01,950	2·16	6·70
7,44,000	23,76,000	81,080	1,03,620	1,19,100	3,03,800	2·46	7·84
5,73,47,000	22,68,37,000	57,93,345	9,72,130	78,75,062	1,46,40,537	3·90	15·50
15,48,000	59,30,000	8,20,280	—	20,60,639	28,80,919	0·54	2·06
6,72,000	25,80,000	3,71,110	9,22,500	7,88,618	20,82,228	0·32	1·24
8,74,000	33,50,000	5,59,630	—	10,75,062	16,34,692	0·54	2·05
15,24,000	58,50,000	4,20,900	7,51,500	9,83,659	21,56,059	0·71	2·72
5,11,000	19,60,000	3,83,150	—	11,09,720	14,92,870	0·34	1·31
6,90,000	26,50,000	4,03,610	1,31,000	5,76,200	†11,10,810	0·52	1·98
16,08,000	61,50,000	6,38,075	14,61,000	8,69,559	†29,68,634	0·50	1·92
22,68,000	87,00,000	10,37,973	—	18,59,698	28,97,671	0·78	3·00
45,12,000	1,50,00,000	21,94,100	—	42,48,948	64,43,048	0·70	2·33
1,42,07,000	5,21,70,000	68,28,828	33,66,000	1,35,72,103	2,36,66,931	0·60	2·20
6,31,000	11,35,000	3,70,130	—	3,69,420	7,39,550	0·85	1·54
11,15,000	42,80,000	2,82,120	6,51,570	4,48,790	13,82,480	0·81	3·10
2,020	3,630	700	510	1,580	2,790	0·73	1·30
32,80,000	1,46,40,000	5,58,000	4,42,000	7,18,580	17,18,580	1·91	8·53
78,90,000	2,95,50,000	11,46,180	6,80,000	13,47,832	31,74,012	2·48	9·30
70,70,000	5,02,60,000	18,03,400	25,70,000	11,80,300	55,53,700	1·27	9·05
41,40,000	2,20,40,000	6,86,950	5,54,000	8,67,364	21,08,314	1·96	10·45
10,55,000	72,75,000	4,85,650	3,44,000	5,86,240	14,15,890	0·75	5·14
	—	46,80,180	45,90,000	47,00,316	1,39,70,496	—	—
31,30,000	1,76,40,000	6,50,000	1,82,000	5,58,600	13,90,600	2·25	12·10

applicable to the Unit. See Section C-4 for explanation.

b. Topographic Mapping

That aerial photo coverage for and including topographic mapping at two-foot contour intervals, and mosaic pictures at scale of one inch to 660 feet be provided for the areas to be served under each project.

c. Investigations

That all dam locations be fully investigated prior to design for foundation stability, leakage and other physical characteristics by borings and laboratory compaction tests, test pits, and soil tests of borrow areas for dam embankment materials; and that soil investigations be made by borings along canal locations and the need for lining determined.

d. Alternative Plans

That alternative plans mentioned heretofore be fully studied and considered from detailed field surveys, explorations, and detailed estimates, particularly the possible elimination of the diversion dam on the Mu River irrigation project, the possible elimination of the diversion dam on the Thitson Chaung development and the lower dam on the Sinthe Chaung development of the Yamethin District irrigation project, and possible sub-surface water source in the Kandaw Village project area to replace the present project plan.

e. Soil Classification and Crop Studies

That classification of the soils in the areas to be irrigated under each project be made in accordance with techniques described in Chapter VIII on Agriculture; and that crop and crop rotation plans suitable to each type of soil and grade be established.

f. Underground Water Resource

That test borings and wells be started without delay in the Yamethin District, Pakokku District and Sagaing District to determine water table and supply and other data for installation of domestic and irrigation wells.

g. Hydrologic Data

That stream-flow gauging be continued and new stations established on all streams, especially those within project developments; that rain-gauge stations be established in the mountains and the records correlated with stream-flow gauging; and that automatic rainfall and stream-flow recorders be installed to obtain continuous records.

2. CONSTRUCTION

Heavy construction, although it has some aspects in common with manufacturing, is a unique industry. No other industry shares comparable requirements for thorough scientific exploration of the site; for climatic and hydrographic record; for geologic and topographic maps; for detailed engineering analyses and drawings; for rapid mobilization and competent supervision of technical field forces and powerful construction equipment; for careful specification and inspection of structures, equipment and materials; and above all for skilled coordination and timing of mobilization, operations and deliveries. Normally, three principals are concerned in such construction work: the Government for which the work is being performed; the engineer who, representing the Government, furnishes the professional and technical skill required in the planning, administration and supervision of construction; and the contractor who furnishes the material, labor and equipment necessary for the physical accomplishment of the work. A customary and necessary exception to these functions is the furnishing by the Government of key or special materials and equipment under specifications prepared by the engineer.

Practically all important public and private irrigation works are constructed by contracting firms who specialize in the particular type of work represented by the projects. Qualified contractors are experienced in the administration of construction operation, including purchase of materials and management of labor. They maintain an organization of trained supervisors, mechanics and workmen who will be available for work with local labor. This specialization does not exist in Burma because of the lack of experience. Local contractors are in a position, however, to take a vital part in the project construction under proper guidance and assistance. They will no doubt furnish the bulk of the construction force.

The engineer is a very important link in a construction program. It is important that he have ability and experience in the line of work represented by the project construction. Upon the award of a contract he assumes direction of the work, approving all construction methods and supervising all operations on behalf of the owner. He is usually represented on the job by an experienced resident engineer and a staff of engineer inspectors and laboratory specialists who control the work, workmanship, materials and equipment. The engineer enforces the provisions of the plans and specifications, and within the limitations of discretion provided in the contract, authorizes appropriate changes and extras.

There are several types of construction contracts under which the project work may be authorized. Any contract must contain a real agreement or meeting of the minds; the subject matter must be lawful; there must be a valid consideration; the parties must be legally competent; and the contract must comply with the provisions of the law with regard to form. Because of the uncertainties and administrative difficulties of construction in this area, competitive bidding procedures might prove so unattractive to contractors that negotiated contracts would be necessary. In general, this type of contract is based on the premise that the Government will pay the actual cost of the work plus some compensation for the services, facilities, and technical knowledge of the contractor.

It is recommended:

a. Construction Schedule and Estimated Expenditures

That the schedule shown in Table IX–20 (*see p.* 246) be adopted for early implementation.

b. Construction Method

That the method of construction be as shown in Table IX–20 for each unit of the project; that the construction be by local or foreign contractor as listed; that construction listed for local contract be supervised by foreign technical personnel employed by the Government; that force account or day labor method of construction be not used for any of the work because of lack of experienced supervisory and procurement personnel unless and until long-range training develops a staff of demonstrated capability.

c. Contracts

That notices be published advising that competitive bids will be received for all the work to be done by local contract, either independently or for a general contractor, and that the award will be given to the lowest qualified bidder.

(1) Competitive Bid Contract

That all local contracts, including subcontracts under a foreign general contract, be on a competitive bid basis, either lump sum or unit price.

(2) Negotiated Bid Contract

That foreign contracts be negotiated on a cost-plus-fixed-fee basis, with a profit sharing clause, with the fixed fee based on a preliminary estimate of the work and the profit sharing provision allowing the contractor a share of any saving if the actual cost is less than the original estimate.

3. DESIGN, SPECIFICATION AND SUPERVISION OF CONSTRUCTION

In general, personnel experienced in field exploration, design, preparation of specifications and supervision of heavy construction are not available in Burma. It is therefore recommended that contracts be negotiated with appropriate foreign engineering firms to furnish the key personnel required to supervise, supplement and train available Burmese engineers in the performance of these necessary functions. Different projects or major segments of different projects may be given to different firms, but all phases of one piece of work from exploration through supervision of construction should be handled by one firm to insure continuity and to prevent the misinterpretations and evasions of responsibility otherwise inevitable. The cost-plus-percentage-fee contract with a fixed minimum is the customary and desirable form of contract for professional services of this kind.

4. ORGANIZATION FOR PLANNING

Project planning is distinguished from the preparation of designs and specifications in the degree to which field data are complete and accurate. "Plans," as distinguished from "designs and specifications," may be based on meager reconnaissance, with topography, foundation conditions, water supply and costs explored only sufficiently to insure that some economic solution exists. As the Government of Burma is now constituted, this function properly rests with the Ministry of National Planning. The further exhaustive exploration required and the preparation of designs and specifications for a project would properly be the function of the engineering firm retained on the project in collaboration with both the Ministry of National Planning and the Department of Irrigation, utilizing the field forces and engineering staffs of both agencies to the limit of their availability. If the design and construction functions of the Department of Irrigation are absorbed in a new Ministry of Engineering Services as recommended in Chapter VI, the work should be carried on with the principal engineering assistance being furnished by that agency.

5. OPERATION AND MAINTENANCE

a. Department of Irrigation

The development and operation of irrigation systems has both engineering and agricultural aspects. The design and construction of irrigation works requires a wide variety of engineering talent familiar with electrical, mechanical, structural, hydraulic and earth features of many kinds. The application of water to crops requires agricultural knowledge in the fields of agronomy, soil chemistry and agricultural engineering. The staffing of the Ministry of Agriculture to provide both the engineering and agricultural staffs would be difficult, and, if similar engineering skills are to be required by other ministries for power, flood control and similar heavy construction operations, perhaps an unnecessary duplication.

It is therefore recommended:

(1) Organization

That the Department of Irrigation continue under the Ministry of Agriculture, but only as an agency for

TABLE

CONSTRUCTION SCHEDULE

(In

Project	Design and Supervision	Contract		1st Year	2nd Year
		By Whom	Type		
Mu River Irrigation					
Storage Reservoir and Dam	Foreign	Foreign	General	35,00,000	1,05,13,000
Diversion and Old Mu Canal	Foreign	Foreign	General	—	78,39,000
West Side Canal System	—	—	—	—	
West Side Canal	Foreign	Foreign	General	—	
Branch System	Local	Local	Subcontract	—	
Chindwin River Pumping	Foreign	Local	Separate	—	
Irrawaddy River Pumping	Local	Local	Separate	—	
Selkpyu Installation	Local	Local	Separate	—	21,92,000
Yamethin District Irrigation					
Sinthe Chaung Dams and	Foreign	Foreign	General	66,93,000	1,14,95,000
Gravity Irrigation System	Foreign	Local	Subcontract	—	—
Sinthe System, Pump and Above	Local	Local	Separate	53,73,000	21,18,000
Thitson Chaung	Foreign	Local	General	9,77,000	64,24,000
Well Pumping	Local	Local	Separate	4,50,000	14,09,000
Yezin Chaung Dam and	Foreign	Foreign	General	—	—
Irrigation System	Foreign	Local	Subcontract	—	
Paunglaung—Yezin System	Foreign	Local	General	—	
Paunglaung River Pumping	Local	Local	Separate	—	
Ngalaik Chaung	Local	Local	General	—	
Swa and Saing Chaungs	Local	Local	General	—	
Kandaw Village Irrigation	Local	Local	General	27,97,000	47,48,000
Loikaw Area Irrigation	Foreign	Local	Separate	6,62,000	14,02,000
Total	—	—	—	2,04,52,000	4,81,40,000

IX - 20

AND EXPENDITURES

· Kyats)

3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year	10th Year
1,81,62,000	1,12,36,000	—	—	—	—	—	—
98,64,000	1,12,25,000	1,42,10,000	—	—	—	—	—
—	57,30,000	70,45,000	1,85,15,000	1,46,93,000	—	—	—
43,54,000	47,38,000	66,73,000	63,22,000	—	—	—	—
32,49,000	37,70,000	39,70,000	36,75,000	36,75,000	—	—	—
1,26,43,000	1,01,23,000	—	—	—	—	—	—
23,46,000	27,87,000	27,52,000	—	—	—	—	—
85,64,000	64,56,000	—	—	—	—	—	—
14,11,000	14,61,000	17,55,000	17,55,000	17,55,000	17,91,000	17,91,000	17,91,000
—	73,80,000	1,47,39,000	—	—	—	—	—
—	—	39,51,000	54,00,000	—	—	—	—
—	—	—	32,62,000	34,51,000	33,99,000	34,49,000	12,94,000
—	—	45,77,000	1,63,47,000	93,67,000	63,73,000	—	—
—	—	—	—	1,73,39,000	3,10,88,000	2,73,67,000	84,88,000
14,85,000	19,30,000	19,22,000	—	—	—	—	—
6,20,78,000	6,68,36,000	6,15,94,000	5,52,76,000	5,02,80,000	4,26,51,000	3,26,07,000	1,15,73,000

Total Expenditures 45,14,87,000

supervision of water distribution, application of water to the land, farm drainage practices, relations with water users, and methods of irrigation farming; that the functions of dredging, river control, flood control, design, construction, reservoir operation, heavy maintenance operations, and general field exploration and field data gathering for design be assigned appropriately to the proposed new Ministry of Engineering Services and the Mercantile Marine Department; and that a new code be prepared to replace the 1933 Public Works Department Code.

(2) Maintenance Equipment

That equipment such as mechanical loaders, draglines, graders, compressors and pumps for dewatering be purchased for more efficient maintenance; that a communications system be installed.

(3) Water Control and Measurement

That all service openings be provided with gates for the measurement of water releases, and that strict control be maintained on the amounts discharged; that each area to be irrigated from a service be studied for crop water use requirements, and that assistance be given the cultivators in ways and means of economically using the available supply.

(4) Water Code and Priority of Use

That a Water and Priority of Use Code be established relating to use of water and the rights of the various users; that all irrigation installations be recorded with the Department of Irrigation, indicating source of supply, installation details, land to be irrigated and location.

(5) Operational Manual

That a new Maintenance, Operation and Inspection Manual be written to replace the present Manual of Departmental Instructions, last printed in 1943.

b. Irrigation Practices

The irrigation developments proposed are extensive and will require large expenditures of funds. Full benefits will depend on the degree of skill with which farm operations are adapted to irrigation. Proper use of water and the correct amount used, drainage provided with its use, use of the right crop for the soil and other practices which facilitate the economical use of the available resources will be the deciding factors in project success. Teaching and demonstration of irrigation practices for water control, measurement, application and drainage are all-important, not only for economy but for proper plant growth and soil use.

It is recommended that the demonstration farms for the promotion and demonstration of improved cultivation practices discussed in Chapter VIII also be used for teaching and demonstrating proper irrigation practices.

6. SPECIFIC PROJECTS

It is recommended that the implementation of the following developments proceed without delay, with the year 1953–54 the target date for starting:

- **(a)** Mu River Irrigation Project—Storage Reservoir Dam.
    - (1) Investigations and surveys.
    - (2) Design.
    - (3) Construction.
- **(b)** Yamethin District Irrigation Project Sinthe Chaung Development.
    - (1) Investigations and surveys.
    - (2) Design.
    - (3) Construction.
- **(c)** Kandaw Village Irrigation Project.
    - (1) Investigations and surveys.
    - (2) Design.
    - (3) Construction.
- **(d)** Yamethin District Irrigation Project—Thitson Chaung Development. Well Irrigation Development.
    - (1) Investigations, surveys and test wells.
    - (2) Design.
- **(e)** Loikaw Area Irrigation Project.
    - (1) Investigations and surveys.

It is recommended that as soon as surveys and investigations have proceeded in sufficient detail, design contracts be negotiated for the first two items.

PART IV

TRANSPORTATION

CHAPTER X

TRANSPORTATION SYSTEM

A. PRESENT SITUATION

1. THE IMPORTANCE OF TRANSPORT

In the general sense, transportation is a form of communication. Together with signal communication, transportation shares the responsibility for the interchange of information and goods. Without the two, there can be neither cultural nor material progress. An efficient transportation system, once brought within the economic and geographic reach of the general population, in addition to meeting immediate and obvious requirements, stimulates the spontaneous and independent growth in settlement, production and trade of all kinds. No quantitative measure of this by-product of transportation has been devised, but it is reasonable to predict that it can amount to several times the original volume of activity in a given area in a few years.

Conversely, the failure of transport and communications quickly reduces any civilization to chaos and lowers the living standard of its people to the barest subsistence standard.

2. INFLUENCE OF TOPOGRAPHY

Surface transportation preferably follows a water grade. The mountain chains and rivers of Burma lie roughly north and south. Transverse communication is more difficult except by air. In the delta region, stream crossings are so numerous that water and air must substitute almost entirely for road and rail. The mountainous terrain along the boundaries of Burma makes communication with her neighbors difficult by land. Sea and air will therefore doubtless remain the dominant forms of foreign transport for a long time.

3. EXISTING TRANSPORT

The effect of the recent war, the postwar reconstruction, the debilitating effects of insurgent activities, and the present status of each of these several modes of transportation, road, rail, air, sea and river, are described in the separate chapters dealing with each of these subjects. In general, schedules and services are limited by lack of road, railway, aerodrome and port improvements, and by the continuing depredations of insurgents. With respect to the latter problem, it may be said in passing that, although some developments must await the full restoration of civil order, to some extent transportation and development must be pushed into the fringes of the disturbed areas with such local protection as can be provided in order to introduce those very opportunities for production, trade and employment which in themselves will aid in alleviating the disaffection.

B. INTERRELATIONS

1. RELATION TO OTHER DEVELOPMENTS

The function of a transportation system for Burma is to handle the domestic and foreign commerce created by the cultural, industrial and agricultural activity of the nation. To a certain extent also, the developments in these fields will provide the fuel, equipment and supplies with which to support transport.

2. INTERDEPENDENCE OF TRANSPORTATION MODES

The several modes of transportation are among themselves both competitive and complementary. Each has its sphere in which it is able to provide the most economic service, but this sphere is not fixed and may change with the changing nature of the traffic, costs of operation, or extension into new areas. Waterways should cost the least to operate per ton mile, and have marked advantages for handling local commodities for which delivery time is relatively unimportant. The railways are suited to approximately constant traffic loads and long hauls for which regularity and reliability of schedules are important. Road transport affords maximum flexibility of routes and schedules and door-to-door service, but is not always able to provide for continuing large tonnage movement over the long hauls. However, private transport may compete successfully for either short- or long-haul traffic in certain commodities. The airways sell speed, and are competitive in any commodity which can afford the premium costs. Airways also sometimes provide the only access to locations to which surface transport is denied either by the high cost of road or rail construction or by the blocking of surface routes by natural causes or hostile military action.

In general, the presence of several modes of transport in one community permits the widest diversity of industrial and agricultural development in that community. Though a community may at one time be adequately served by one or more modes of transport, it does not necessarily follow that the addition of another mode of transport might not be advantageous. The presence of a new mode of transport may stimulate the production or exchange of new or additional commodities not previously produced. It may be said, therefore, that the common goal of all the transport systems should be to provide the widest variety of service and the most frequent and convenient service to every community, the current or potential traffic of which will support the service, either independently of the economics of any other activity or in combination with the economics of another mode of transportation or activity, whose development justifies the sharing of a transport facility's economic burden.

3. DELINEATION OF TRANSPORT FUNCTIONS

The functions and services furnished by the several modes of transportation are separately described in succeeding chapters. To bring these functions into clear perspective, it is suggested that, in addition to the common functions stated in the preceding paragraph, the separate functions of these several modes of transportation should be defined in terms somewhat similar to the following.

a. Seaports

At designated seaports, to plan, provide, operate and maintain facilities for ocean and river shipping: channels, harbor structures, handling facilities for passengers and freight, terminal facilities for private and public agencies serving or served by water transport, communications and navigation aids. To license, lease, and otherwise direct and control the use of port facilities, and to direct and control waterborne traffic.

b. Ocean Shipping

To plan, provide, subsidize and operate oceangoing vessels in domestic and foreign service.

c. Inland Waterways

To plan, provide, subsidize, and operate river vessels in domestic service on the navigable rivers. To plan, provide, operate, lease and maintain facilities for river shipping (except at seaports): river ports, terminal and loading facilities for private and public agencies serving or served by inland water transport, communications (except as handled by the Telecommunications Department) and navigation aids. To direct and control waterborne river traffic.

d. Railways

To plan, provide, operate and maintain railway transport and transport facilities to all communities and customers, domestic or foreign, the traffic with which or other value as public policy will economically support the investment and operating costs.

e. Highways

To plan, provide and maintain a competent network of highways and roads and their associated structures connecting all domestic and neighboring communities, from the serving of which the public benefit shall be found to warrant the capital and maintenance costs.

f. Airways

To plan, provide, operate and maintain airways, transport and transport facilities to all communities and customers, domestic or foreign, the traffic with which or other value as public policy will economically support the investment and operating costs.

Whenever joint facilities or connecting schedules are found desirable by any or several means of transport, it should be the obligation of any means of transport so requested to participate in such facilities or to provide such services by joint plan, any expenses not directly carried by the traffic being contributed by the requesting transport agency.

C. OPERATING REQUIREMENTS

1. COMPARISON OF PROBLEMS

(a) In the sphere of procedures, correlation and coordination are required particularly between the activities of the Department of Communications and each of the transport agencies. Subject to the approval of the Ministry of Transport and Communications only in case of dispute, the Department of Communications should decide the extent to which it can provide communications and communications equipment services requested by the transport agencies. While controlling the allocation of communications facilities, the Department should be liberal in affording independent nets and facilities needed by the transport agencies. Coordination will also be required between highways and the other transport agencies in providing feeder roads to rail, water and air terminals; and between seaports and inland waterways in providing joint use facilities and operating procedures at seaports. Combined passenger booking offices would also be advantageous in some communities and at major rail, air and water terminals. Periodic conferences should be held between operating counterparts of the several transport agencies for comparison of methods of dispatching, booking, communications, freight and passenger handling, administration, equipment, supplies, maintenance, finance and procurement.

(b) In the sphere of supplies, fuel, equipment, maintenance and purchasing, pooling of activities will probably be found advantageous in such matters as:

(1) Communications equipment—purchase and installation by Department of Telecommunications.

(2) Diesel fuel—purchase by Ministry and storage and distribution by Railways.

(3) Maintenance organization—common regional or divisional patterns may be found useful. Maintenance is too easily neglected, must be serviced by strong organization adequately equipped, and must be continuous.

(4) Crushed stone and other aggregates—quarrying and production by Highways, transport and use by other agencies.

(c) In the sphere of administration, each has the common requirement for sufficient autonomy to properly order its own affairs, to expediently expend funds allocated, and to utilize equipment and supplies which should be at its own disposal. Each has a training problem and should be encouraged to establish and conduct instruction, both full time and on-the-job, at whatever level required. Training assistance and training aids should be furnished by an adjunct of the university or other central agency as required.

(d) In the sphere of basic data, research and development, each agency requires the stimulus of continuing analysis, study, collection of data, and technical research. Each should be concerned with the collection and comparison of operating facts, with the trial of improved procedures and the development and trial of improved equipment and materials. Scientific research and experimentation should be brought to bear on transport problems with the collaboration and assistance of the transport agencies. Official and technical personnel of the transport agencies should be sent abroad for observation and study of overseas practices, and funds should be made available for subscription to a wide variety of technical publications.

2. TRANSPORTATION RATES

Reasonable transportation costs are necessary for the economic development of any country or area. The rates for carrying goods and passengers required for new development or normal governmental, cultural and commercial activities in any section of the country should support the cost of the services, but should not be so high as to discourage enterprise and limit traffic.

Transportation costs depend upon the volume of traffic available to the transporting agency. If the hauling facility can be operated at a relatively high percentage of its capacity, assuming that the investment in the plant and equipment has been reasonable, the rates that can be charged for service are certain to be reasonable. When it is necessary to extend new transportation service into an area for the purpose of development it will be necessary for Government to (1) subsidize the facility until sufficient traffic develops to support it or (2) increase rates on other sections of the system until a volume of traffic adequate to support the investment and operating costs of the facility has been attained.

Where Government is the owner of essentially all means of transport except highway vehicles, the regulation of rates to provide equitable costs to all communities served is not difficult. The records necessary to provide the basis for the establishment of equitable transportation rates are readily available to it. It is necessary to establish an independent staff of administrators, accountants and engineers to review and analyze the records of the government-owned transportation systems. This analysis should set up; first, an accurate appraisal of the physical value of the plant and equipment of the transportation facility; second, a statement of the annual operating, maintenance and other variable costs entailed in carrying goods and passengers and rendering other transportation service; and third, a study of the amount of traffic, passengers, goods and other services handled, giving consideration to the type of commodity, its origin and destination, special equipment required for handling and other factors affecting its cost of transportation. From these data, rate schedules can be derived for all services rendered by the transportation agencies that will be equitable for all commodities and between all communities, and that will support the transportation service.

Existing rates are, in general, not set up to foster nation-wide development. While it has not been possible to make a comprehensive analysis of the rate structure of the principal transportation agencies, some spot checks have been made. These are presented in Table X–1 (*see next page*).

The present rate for the movement of cement from Thayetmyo to Rangoon is K38.92 per ton or K0·147 per ton mile. A careful estimate of providing suitable equipment for this service and including all operation and administration costs indicates that the transportation should be provided for about K0.04 per ton mile. The present charge for transporting coal from Kalewa to Rangoon is given as K110.50 per ton or K0·166 per ton mile. The estimated cost of providing this service when the mine is in operation and large quantities are being moved is K35.75 per ton or K0·0537 per ton mile. The cost of transporting a bulldozer in 1953 from Rangoon to Kalewa for exploration and development purposes was nearly K10.00 per ton mile, a rate which no development program could support. The total transport costs for this equipment

TABLE X – 1

COMPARISON OF RAILWAYS AND IWTB RATES

(kyats/ton)

Commodity	Agency	Rangoon to		
		Myingyan	*Mandalay*	*Monywa*
Cement	BR	40.44	42.78	51.33
	IWTB	57.17	64.56	62.22
Rice	BR	40.44	42.78	51.33
	IWTB	66.89	76.22	73.11
Grains, Pulses	BR	40.44	42.78	51.33
	IWTB	38.11	43.17	41.61
Sugar	BR	57.56	58.69	72.33
	IWTB	66.89	76.22	73.11
Salt	BR	40.44	42.78	51.33
	IWTB	57.17	64.56	62.22

IWTB Miscellaneous Transport Cost per ton mile	
IWTB Kalewa Coal K110.50/T	K0·166/ton mile
IWTB Thayetmyo Cement K38.92/T	K0·147/ton mile
Estimated Costs (Project Reports)	
Kalewa Coal to Rangoon	K0·0537/ton mile
Chauk Oil to Rangoon	K0·0267/ton mile
Transportation—Bulldozer from Mandalay to Kalewa	K55,500
20 Tons at 280 miles = 5,600 ton miles	
$K\frac{55,500}{5,600}$	K9.91/ton mile.

from Rangoon to Kalewa amounted to approximately K70,000 or nearly 85% of the first investment cost. These representative examples certainly indicate that a consistent rate structure must be adopted.

The existing rates by rail are more reasonable than water rates, an anomaly that is difficult to understand since throughout the world water rates are consistently lower than rail rates. However, it is understood that government-owned and operated riverine transport realizes a substantial annual profit while Railways operates at an annual loss.

The average goods rates for commodities moved by rail since the close of World War II are as follows:

1946–47	K0·1057 per ton mile
1947–48	K0·0845 ,, ,, ,,
1948–49	K0·1042 ,, ,, ,,
1949–50	K0·1925 ,, ,, ,,
1950–51	K0·1590 ,, ,, ,,
1951–52	K0·1432 ,, ,, ,,

The average comparable prewar rate was K0.04 per ton mile. If the prewar rate is converted by the rise-in-cost indices (about 3·5), the 1951–52 rate should amount to K0.14 which approximates the actual rate of K0·1432.

The present high rates are influenced to a major extent by limited traffic movements and by the necessity of confining operations to the daylight hours since dacoity and insurgency will not permit operations during the night.

Expensive transportation costs and inadequate service will be a major deterrent to the development and normal commerce of the country unless steps are taken by Government to provide an effective and independent regulatory agency for the several modes of transport.

3. TRANSPORT COMMISSION

To encourage fair and healthy competition between the several transport agencies, to control their standards of service, to insure coordinated services and economic use of joint facilities, and to control rates in the interest of the public, there must be a regulating commission, free of operating responsibilities and pressures, and staffed and equipped to analyze the social, economic and technical aspects of the national transport problems. The specific needs for such a body are pointed out in the succeeding chapters. It is therefore recommended that the necessary legislative and administrative action be undertaken to create, in the Ministry of Transport and Communications, a Transport Commission having organization, functions and responsibilities similar to those described below.

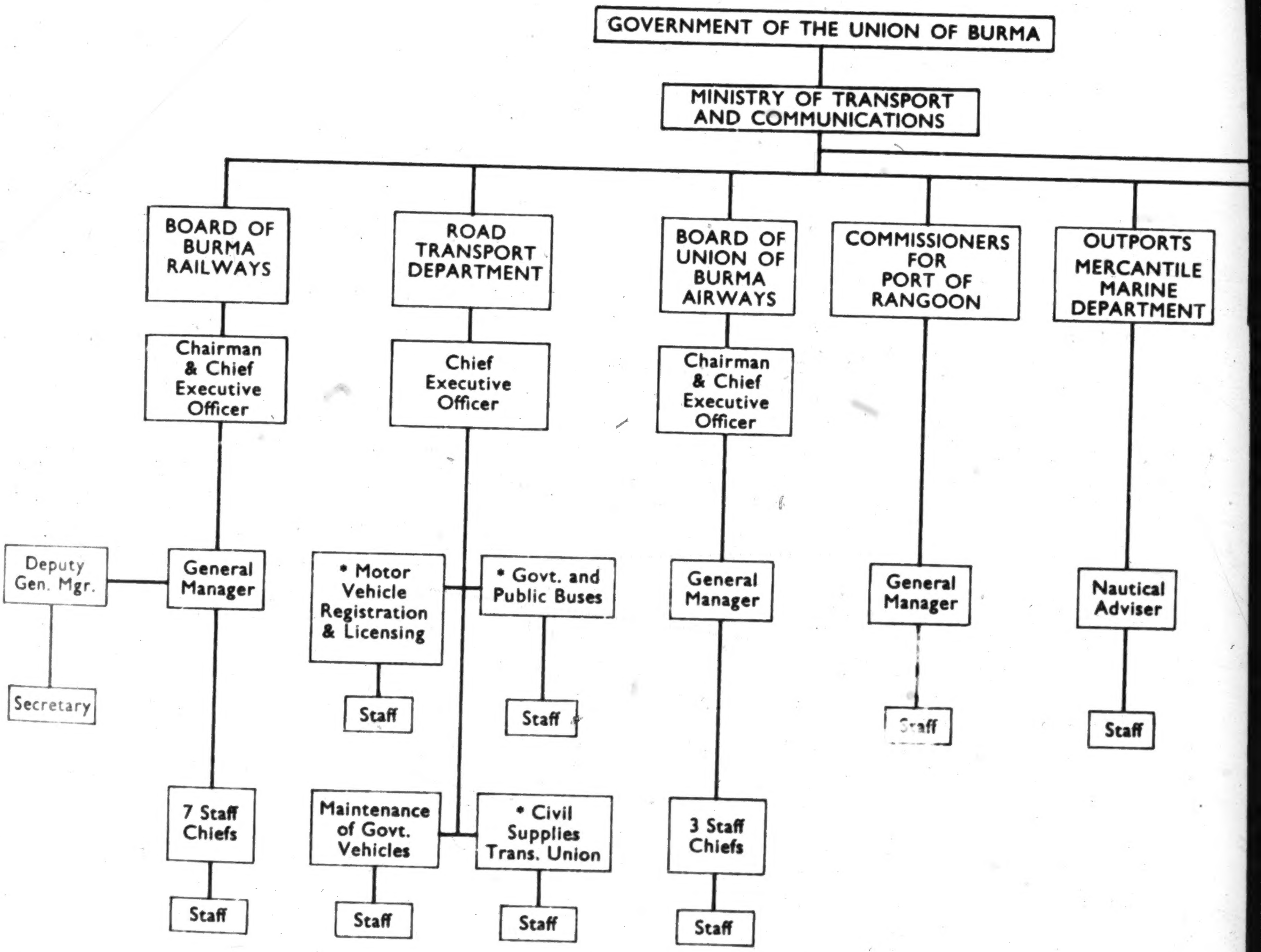
a. Organization. It is proposed that the Commission be composed of three men, all experienced in the field of transportation, and if possible contributing between them experience in social, economic and technological areas. They should devote full time to their work and should be supported by an adequate staff and by authority to engage specialists for advice on particular problems. A suggested organization chart is presented in Plate 1.

b. It is suggested that the duties and responsibilities of the Commission be formulated in terms similar to the following:

(1) To develop, propose, effect and administer the regulatory aspects of a national transport policy.

(2) To control the extent and variety of common carrier transport or public supported services and facilities in or subject to the jurisdiction of the Government by review and approval or rejection of proposals for the extension or abandonment of common carrier and publicly supported transport services and facilities.

(3) To develop, establish and maintain an economic


GOVERNMENT OF THE UNION OF BURMA
MINISTRY OF TRANSPORT AND COMMUNICATIONS
BOARD OF BURMA RAILWAYS
Chairman & Chief Executive Officer
Deputy Gen. Mgr.
General Manager
Secretary
7 Staff Chiefs
Staff
ROAD TRANSPORT DEPARTMENT
Chief Executive Officer
* Motor Vehicle Registration & Licensing
Staff
* Govt. and Public Buses
Staff
Maintenance of Govt. Vehicles
Staff
* Civil Supplies Trans. Union
Staff
BOARD OF UNION OF BURMA AIRWAYS
Chairman & Chief Executive Officer
General Manager
3 Staff Chiefs
Staff
COMMISSIONERS FOR PORT OF RANGOON
General Manager
Staff
OUTPORTS MERCANTILE MARINE DEPARTMENT
Nautical Adviser
Staff

* Recommended function.
** Includes regulation of petroleum pipe lines.

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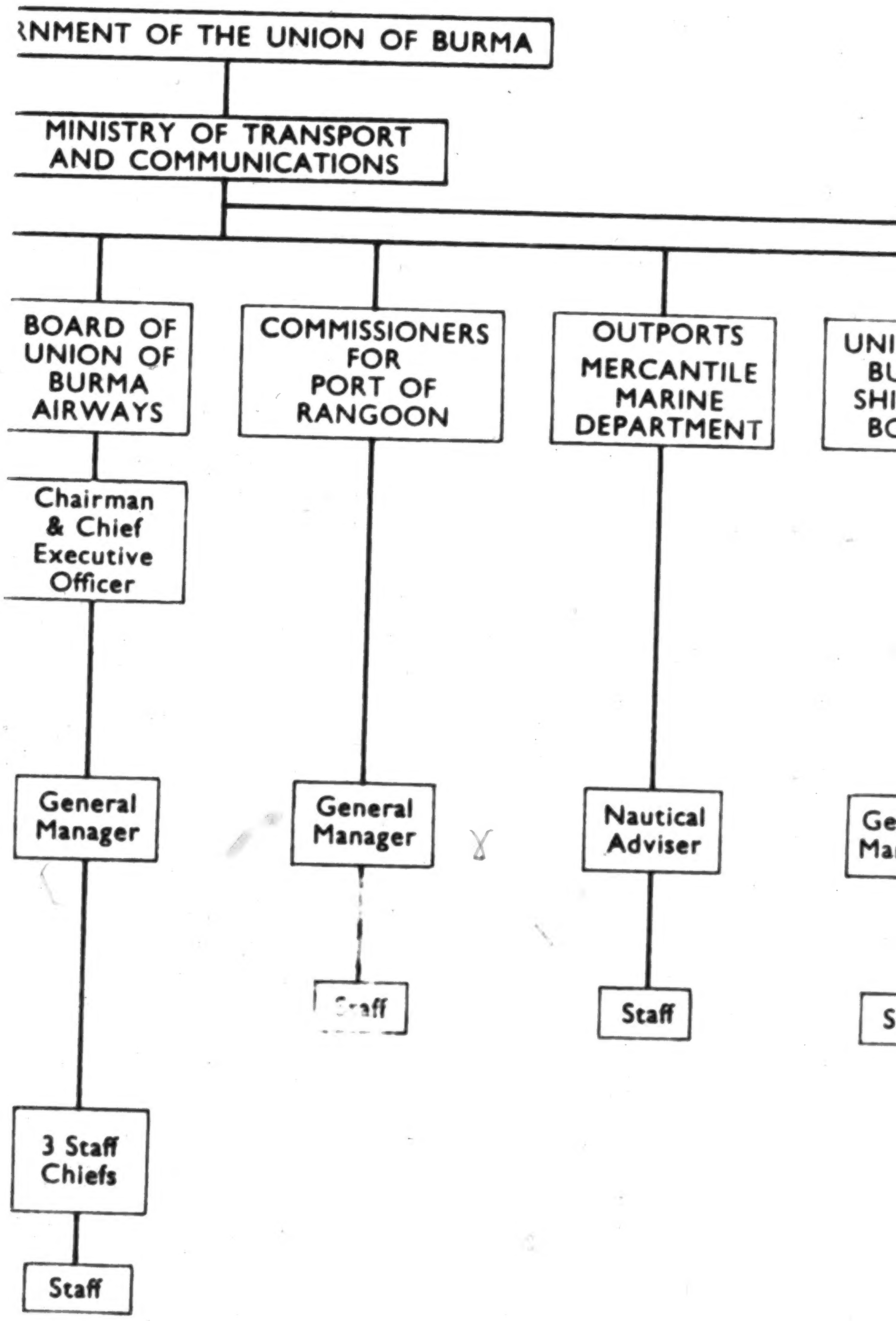
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MINISTRY OF TRANSPORT AND COMMUNICATIONS
BOARD OF UNION OF BURMA AIRWAYS
Chairman & Chief Executive Officer
General Manager
3 Staff Chiefs
Staff
COMMISSIONERS FOR PORT OF RANGOON
General Manager
Staff
OUTPORTS MERCANTILE MARINE DEPARTMENT
Nautical Adviser
Staff
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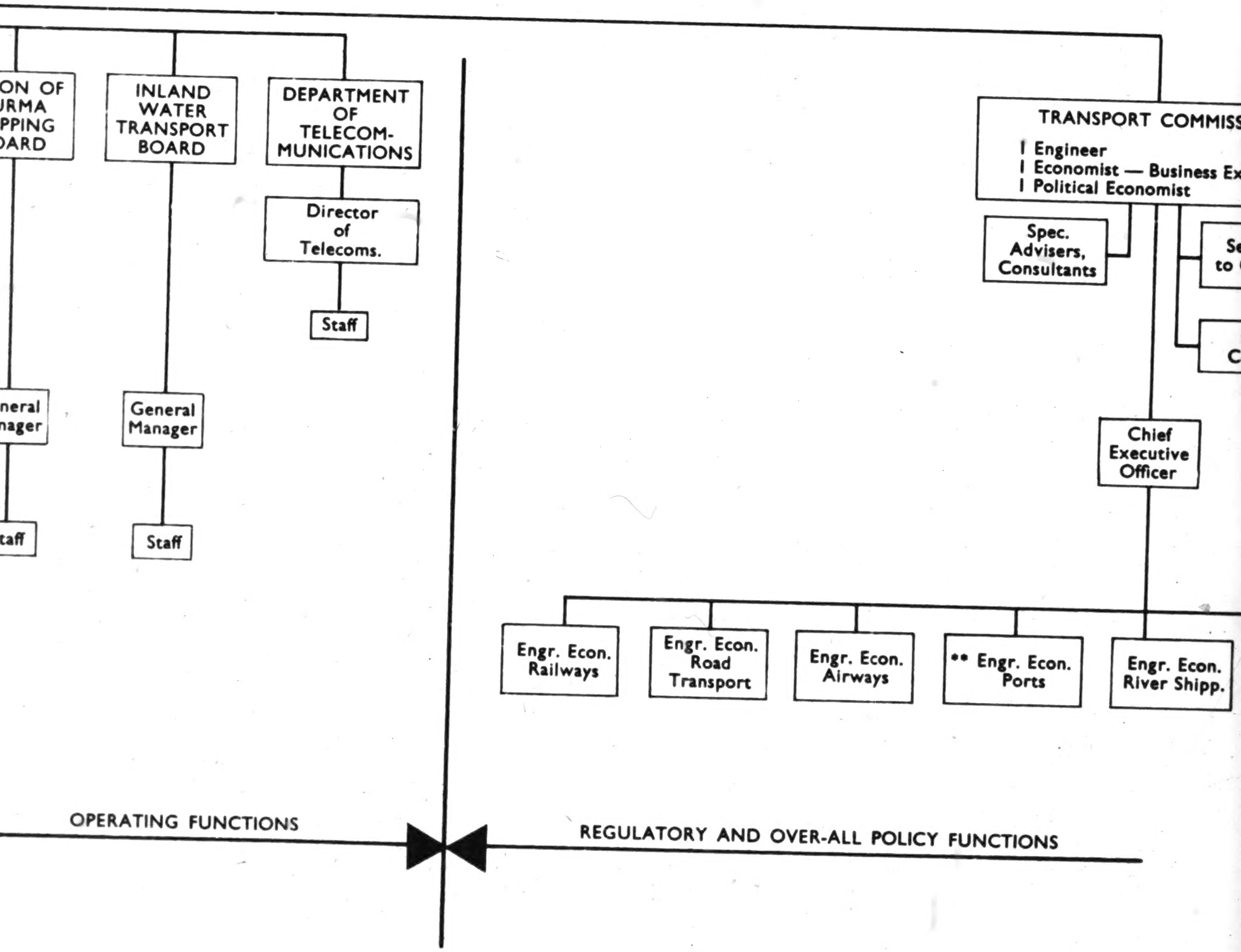
ON OF
URMA
PPING
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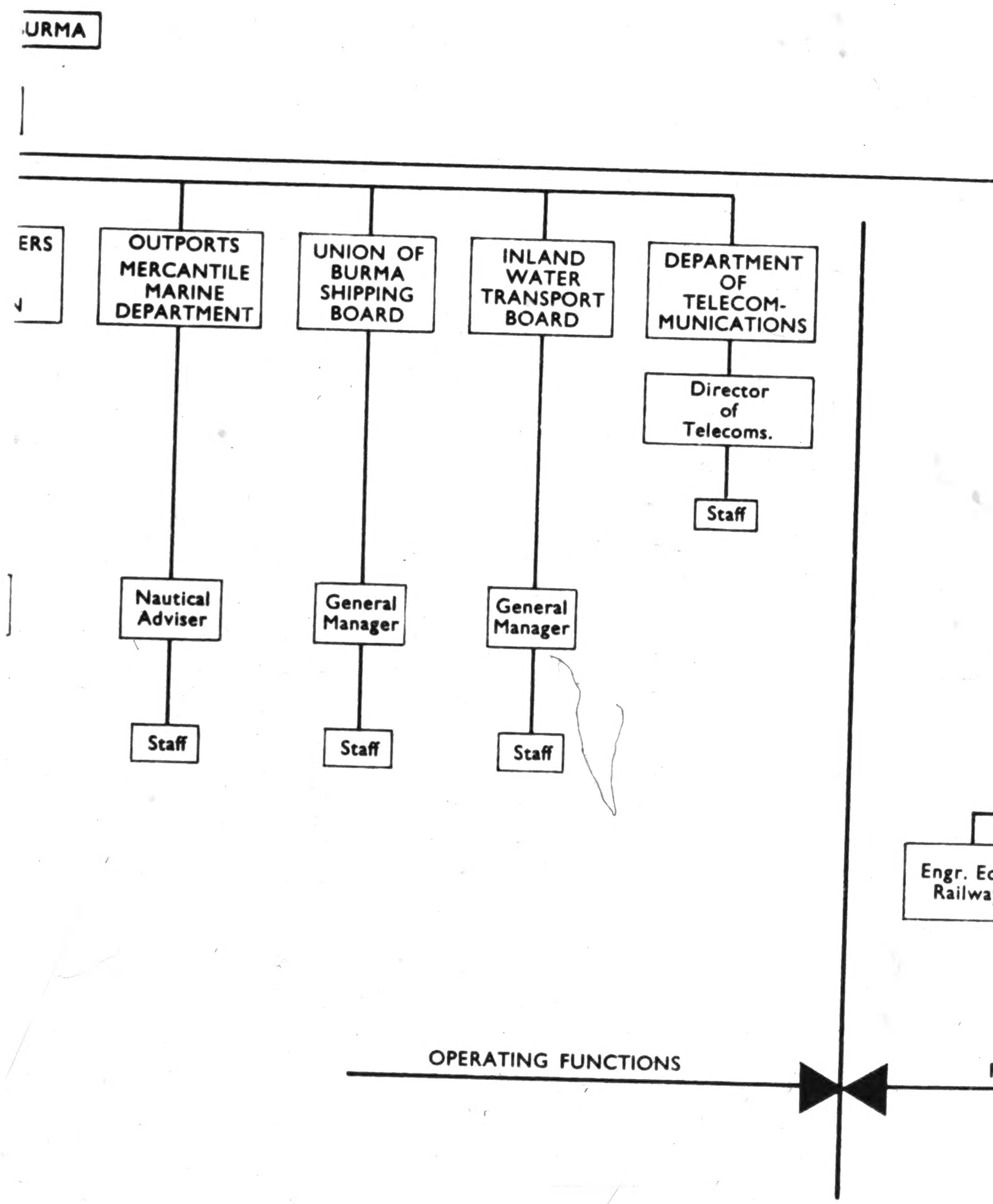
INLAND WATER TRANSPORT BOARD
General Manager
Staff
DEPARTMENT OF TELECOMMUNICATIONS
Director of Telecoms.
Staff
TRANSPORT COMMISS
I Engineer
I Economist — Business Ex
I Political Economist
Spec. Advisers, Consultants
Se
to
C
Chief Executive Officer
Engr. Econ. Railways
Engr. Econ. Road Transport
Engr. Econ. Airways
** Engr. Econ. Ports
Engr. Econ. River Shipp.
OPERATING FUNCTIONS
REGULATORY AND OVER-ALL POLICY FUNCTIONS

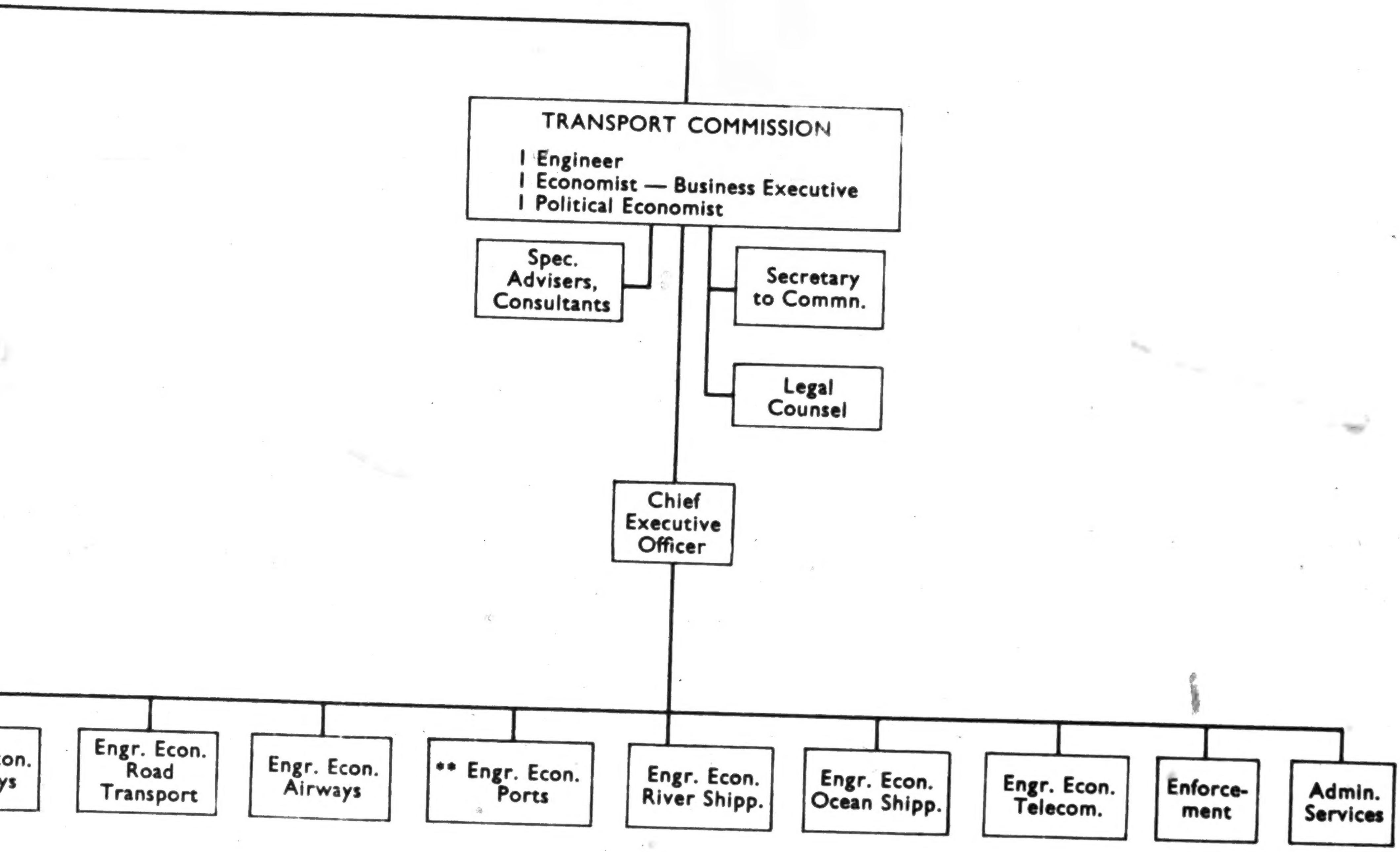
ORGANIZATION CHART

try of Transport and Communications and
Transport Commission


URMA
ERS
N
OUTPORTS MERCANTILE MARINE DEPARTMENT
UNION OF BURMA SHIPPING BOARD
INLAND WATER TRANSPORT BOARD
DEPARTMENT OF TELECOMMUNICATIONS
Director of Telecoms.
Staff
Nautical Adviser
General Manager
General Manager
Staff
Staff
Staff
Engr. Ec
Railwa
OPERATING FUNCTIONS

ORGANIZATION CHART

Ministry of Transport and Communications and Transport Commission


TRANSPORT COMMISSION
I Engineer
I Economist — Business Executive
I Political Economist
Spec. Advisers, Consultants
Secretary to Commn.
Legal Counsel
Chief Executive Officer
on.
ys
Engr. Econ. Road Transport
Engr. Econ. Airways
** Engr. Econ. Ports
Engr. Econ. River Shipp.
Engr. Econ. Ocean Shipp.
Engr. Econ. Telecom.
Enforcement
Admin. Services

REGULATORY AND OVER-ALL POLICY FUNCTIONS

CHAPTER X, PLATE I

and non-discriminatory rate structure designed to serve the best interests of the Union of Burma as a whole, with due regard to the establishment of through rates and incentive rates for the encouragement of particular areas of traffic, and with due regard to the proper distribution, publication and enforcement of the rate regulations.

(4) To regulate and administer common contract carriers by:

(*a*) Prescribing licensing procedures for and licensing common carriers.

(*b*) Establishing common accounting forms, bills of lading and other administrative forms for common purposes.

(*c*) Developing and administering the establishing of safety rules, requirements for safety appliances and equipment, and (upon the recommendation of the interested transport service) limiting loads and other physical and operating criteria.

(*d*) Supervising, investigating and fixing responsibility for serious accidents.

(*e*) Compiling, analyzing and publishing pertinent statistics, including traffic records.

c. It is suggested that in performing the foregoing functions the Transport Commission follow procedures of somewhat the following nature:

(1) The rate structure, operating regulations, safety regulations and administrative procedures applicable to transport in the Union of Burma should be compiled, published and distributed in one or more conveniently bound volumes.

(2) Initial and continuing studies required for the development and compilation of rates and regulations should be based primarily on statistical data to be furnished by the transportation agencies, at first on the basis of initial requests, and subsequently on a periodic basis.

(3) In applying for extension, modification, or abandonment of services and facilities, the several transport agencies should file such information and supporting data as may be prescribed by the Transport Commission.

(4) With respect to the investigation of serious accidents, the transport agencies should file a "flash" report with the Transport Commission by the most expeditious communication means available. Representatives of the Transport Commission should visit the scene of the accident by the most urgent transport means available, should immediately initiate inquiry and should outline and initiate any further investigation required.

D. REVIEW OF RECOMMENDATIONS

The detailed recommendations relating to each of the modes of transport are contained in the pertinent succeeding chapters. With respect to transportation problems as a whole, the dominant need is for a Transport Commission, and it is recommended that early steps be taken to create and place in operation such a commission. It is further recommended that the Ministry of Transport and Communications support the several transport agencies in their efforts to obtain needed administrative autonomy, to develop adequate maintenance and maintenance organization, and to secure the needed extensions, improvements and training facilities.

CHAPTER XI

BURMA RAILWAYS

A. INTRODUCTION

1. IMPORTANCE OF RAILWAYS

Prior to the war, Burma Railways carried from 80 to 90% of the freight and practically all passengers except those destined for points not reached by rail. Although Burma's well-developed inland waterways provide the economical solution for certain types of freight and passenger movement, the speed and accessibility of railways for other types of movement are indispensable. The success of the present plans for the development of agriculture, industry and commerce will therefore depend in large part upon the efficient operation of an adequate railroad net fully coordinated with other means of transport, each handling the traffic in the sphere to which it is best adapted.

2. PURPOSE OF REPORT

The purpose of this report is to examine the existing situation of the railways, to review the current rehabilitation plans of Railways management, and to present recommendations for the further improvement and adaptation of Burma Railways to the integrated development of the country as a whole. In this connection plans are in preparation for the Chief Engineer and the Chief Mechanical Engineer of Burma Railways to spend two months in the United States for the study of American railroad practices, some of which form the basis for certain of the recommendations in this report.

B. HISTORY

1. PREWAR DEVELOPMENT

The first railway in Burma began service in 1877 (prior to the British annexation of upper Burma in 1886) with a 161-mile meter gauge line from Rangoon to Prome. By 1889, the 385-mile line between Rangoon and Mandalay was in operation. By 1903, the Myingyan, Myitkyina, Alon, Lashio and Bassein–Letpadan branches, aggregating 767 miles, were opened in the order named, bringing the total to 1,313 route miles. By 1930, the Martaban, Kyangin, Shwenyaung, Ye, Kyaukpadaung and Paleik-Myingyan branches, aggregating 582 miles, were opened in the order named. By World War II the total length of meter gauge line reached 2,058 route miles.

In 1896, the Irrawaddy State Railway which had initiated the development was succeeded by a private corporation, the Burma Railways Company, Ltd., of London, under a lease which expired at the end of 1928, when control was assumed by the Indian Railway Board. The monumental 3,760 ft. high-level Ava Bridge, constructed in 1934, closed the water gap between Rangoon and Myitkyina. The prewar freight and passenger services ranked high in physical performance among the meter gauge railways of the world. Financially, however, from 1938 to 1940, substantial deficits were accumulated until the added war traffic to China via Lashio and the Burma Road produced a profit.

2. WAR DAMAGE

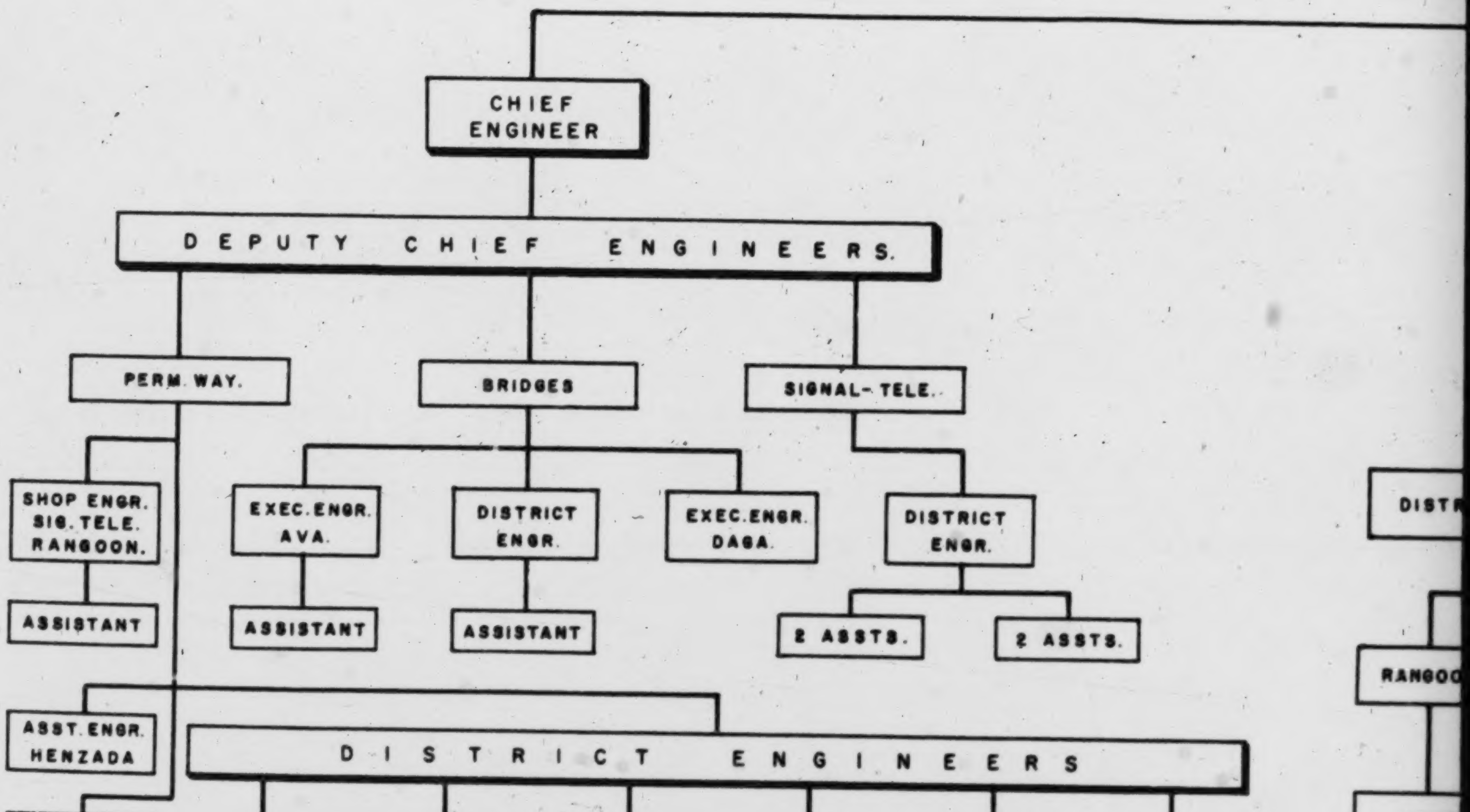
Damage to Burma Railways during World War II was twofold. Initially both defensive operations and enemy attacks were concentrated on rail lines. Secondly, during four years of enemy occupation, Allied forces directed unremitting aerial attacks on all lines of communication. The re-conquest of Burma constituted a third phase of destruction. During the combat action the damage by both the attacking and defending forces was systematic and thorough.

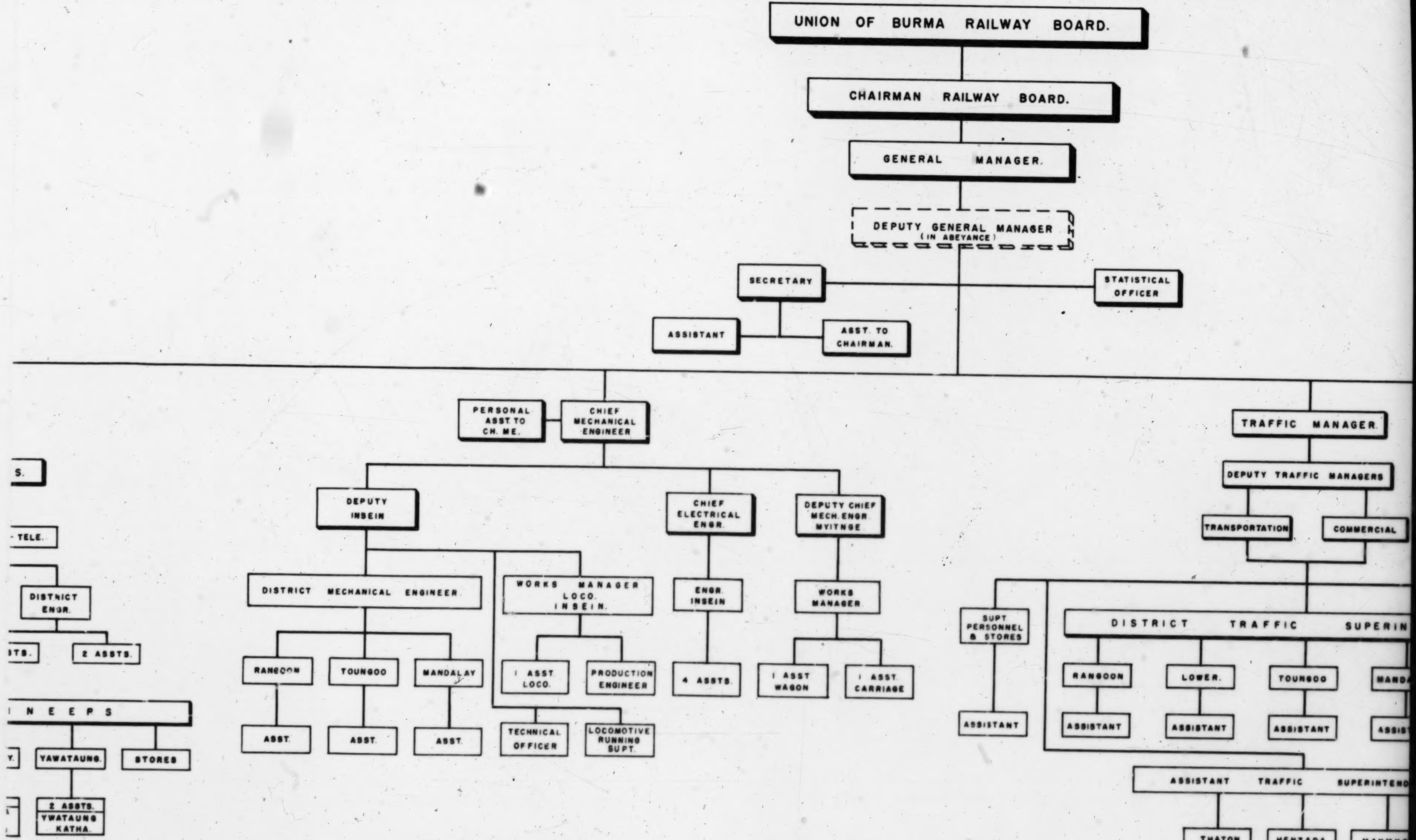
No single section of Railways escaped heavy damage from one belligerent or the other. Table XI-1

TABLE XI – 1

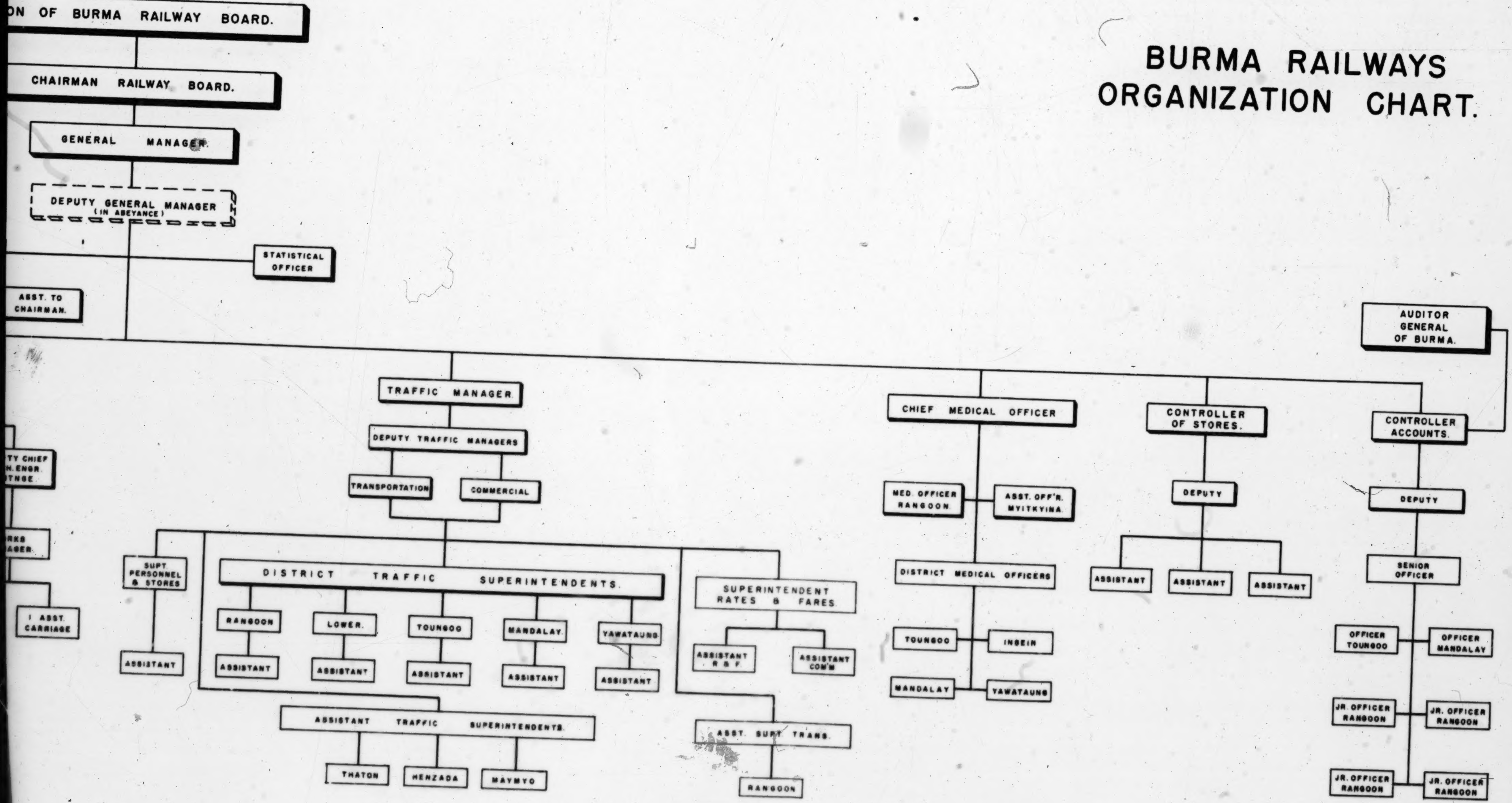
WAR DAMAGE

Item	*Amount*	*Destruction*
Locomotive Works, Insein		Crippled
Carriage and Wagon Works, Myitnge		Crippled
Rails and Accessories	600 miles	Disappeared
Bridges		
9 Special Class	11,657 ft.	Great damage
6 Major	3,987 ft.	Destroyed
218 Important	31,286 ft.	Badly damaged
54 Other	5,361 ft.	Required repair
Major Stations, with Facilities and Equipment	44	Destroyed
Rolling Stock		
Locomotives	285 of 350	Destroyed
Goods Wagons	7,000 of 9,500	Destroyed
Coaching Service Vehicles	956 of 1,156	Destroyed


CHIEF ENGINEER
DEPUTY CHIEF ENGINEERS.
PERM. WAY.
BRIDGES
SIGNAL-TELE.
SHOP ENGR. SIG. TELE. RANGOON.
ASSISTANT
EXEC. ENGR. AVA.
ASSISTANT
DISTRICT ENGR.
ASSISTANT
EXEC. ENGR. DAGA.
DISTRICT ENGR.
2 ASSTS.
2 ASSTS.
ASST. ENGR. HENZADA
3 ASSTS. RANGOON.
DISTRICT ENGINEERS
RANGOON.
4 ASSTS.
3 RANGOON
1 THARRAWADDY
PEGU.
2 ASSTS.
PEGU
MOULMEIN
TOUNGOO
2 ASSTS.
TOUNGOO.
KALAW.
MANDALAY.
3 ASSTS.
MYITKYINA
THAZI
MAYMYO.
YAWATAUNG.
2 ASSTS.
YWATAUNG
KATHA.
STORES
DISTR
RANGOO
ASST.


UNION OF BURMA RAILWAY BOARD.
CHAIRMAN RAILWAY BOARD.
GENERAL MANAGER.
DEPUTY GENERAL MANAGER
(IN ABEYANCE)
SECRETARY
STATISTICAL OFFICER
ASSISTANT
ASST. TO CHAIRMAN.
PERSONAL ASST. TO CH. ME.
CHIEF MECHANICAL ENGINEER
S.
- TELE.
DISTRICT ENGR.
STS.
2 ASSTS.
INEEPS
Y.
YAWATAUNG.
STORES
2 ASSTS.
YWATAUNG KATHA.
DEPUTY INSEIN
DISTRICT MECHANICAL ENGINEER.
RANGOON
TOUNGOO
MANDALAY
ASST.
ASST.
ASST.
WORKS MANAGER LOCO. INSEIN.
1 ASST LOCO.
PRODUCTION ENGINEER
TECHNICAL OFFICER
LOCOMOTIVE RUNNING SUPT.
CHIEF ELECTRICAL ENGR.
ENGR. INSEIN
4 ASSTS.
DEPUTY CHIEF MECH. ENGR. MYITNGE
WORKS MANAGER.
1 ASST WAGON
1 ASST. CARRIAGE
TRAFFIC MANAGER.
DEPUTY TRAFFIC MANAGERS
TRANSPORTATION
COMMERCIAL
SUPT PERSONNEL & STORES
ASSISTANT
DISTRICT TRAFFIC SUPERIN
RANGOON
LOWER.
TOUNGOO
MANDA
ASSISTANT
ASSISTANT
ASSISTANT
ASSIS
ASSISTANT TRAFFIC SUPERINTEND
THATON
HENZADA
MAYMYO

BURMA RAILWAYS ORGANIZATION CHART.



ON OF BURMA RAILWAY BOARD.
CHAIRMAN RAILWAY BOARD.
GENERAL MANAGER.
DEPUTY GENERAL MANAGER (IN ABEYANCE)
STATISTICAL OFFICER
ASST. TO CHAIRMAN.
AUDITOR GENERAL OF BURMA.
TRAFFIC MANAGER.
DEPUTY TRAFFIC MANAGERS
TRANSPORTATION
COMMERCIAL
TY CHIEF H. ENGR. TNGE.
RKS AGER.
I ASST. CARRIAGE
SUPT. PERSONNEL & STORES
ASSISTANT
DISTRICT TRAFFIC SUPERINTENDENTS.
RANGOON
LOWER.
TOUNGOO
MANDALAY.
YAWATAUNG
ASSISTANT
ASSISTANT
ASSISTANT
ASSISTANT
ASSISTANT
ASSISTANT TRAFFIC SUPERINTENDENTS.
THATON
HENZADA
MAYMYO
SUPERINTENDENT RATES & FARES.
ASSISTANT R & F.
ASSISTANT COM'M
ASST. SUPT. TRANS.
RANGOON
CHIEF MEDICAL OFFICER
MED. OFFICER RANGOON.
ASST. OFF'R. MYITKYINA.
DISTRICT MEDICAL OFFICERS
TOUNGOO
INSEIN
MANDALAY
YAWATAUNG
CONTROLLER OF STORES.
DEPUTY
ASSISTANT
ASSISTANT
ASSISTANT
CONTROLLER ACCOUNTS.
DEPUTY
SENIOR OFFICER
OFFICER TOUNGOO
OFFICER MANDALAY
JR. OFFICER RANGOON
JR. OFFICER RANGOON
JR. OFFICER RANGOON
JR. OFFICER RANGOON

PLATE NO. I

K. T. A. RANGOON. JUNE, 1953.

highlights, but cannot fully convey, the real extent of the losses to all features of the railway system. Table XI–2 summarizes the extent of the damage in monetary terms, and indicates a total wartime loss in plant, equipment and rolling stock of 48%. As described in the Edwards Evaluation Report, by the end of the war Burma Railways had "ceased to exist as a transportation system."

TABLE XI – 2

CAPITAL AT CHARGE AND POSTWAR EVALUATION

Accounts	1942–43 (*Rupees*)*	1945–46 (*Rupees*)*
1. Preliminary Expenses	41,95,955	41,95,955
2. Land	73,06,971	73,06,971
3. Structural Engineering Works	22,05,28,120	13,18,14,149
4. Equipment	1,93,28,170	6,66,320
5. Rolling Stock	5,94,63,190	55,13,600
6. General Charges	2,36,99,154	1,32,72,222
Minbu-Pakokku Construction†	56,52,039	—
Suspense Invoices and Stores	50,98,064	38,06,760
Total	34,52,71,663	16,65,75.977‡

* Rupees now designated kyats.
† Land only, construction abandoned.
‡ At 1936–37 prices.

3. POSTWAR CHANGES IN ADMINISTRATION

During the Japanese occupation of Burma, the Railways administration moved to India where it laid plans for postwar restoration of Railways properties. On January 4, 1948, Burma became an independent nation, and in 1951, under provisions of the "Union of Burma Railways Act," Burma Railways was transferred to the present Railway Board operating under the Ministry of Transport and Communications.

4. POSTWAR DISRUPTION AND RECOVERY

On re-occupation, Railways made astonishing progress in rehabilitation, following generally the plans laid in India. Rolling stock was obtained from the Allied Armies, and from India and the United Kingdom, and facilities were rebuilt or reconditioned to the extent that by the Burmese Independence Day, January 4, 1948, limited service had been restored on some 1,800 route miles of line. A period of wild insurgency ensued, during which the disaffected elements have persistently damaged and disrupted the system, at one time controlling early in 1944 all but some 20 miles of line in the vicinity of Rangoon. The continued destruction has been particularly vicious. Major bridges have again been destroyed. Night train services are entirely suspended, and armed escorts are still required in some areas. Table XI–3 indicates a two-year measure of the postwar destruction and shows why the execution of the rehabilitation program of Burma Railways has been seriously delayed.

TABLE XI – 3

INSURGENT SABOTAGE

Incidents	*1950–51**	*1951–52**
Incidents		
Track sabotage	198	187
Trains fired on from ambush	32	23
Railway buildings burned	59	17
Bridges blown up	204	176
Trains mined	49	48
Total	542	451
Casualties		
Passengers killed	29	32
Railway staff killed	9	15
Passengers injured	55	71
Railway staff injured	50	33
Total	143	151

* Fiscal years postwar end September 30.

Notwithstanding the disturbed postwar conditions, Burma Railways expended K2,651 lakhs for additions to September 30, 1952. Capital at charge, on the basis of prewar books, was K3,452 lakhs on October 1, 1945. After writing off K1,787 lakhs in 1948–49 for war damage, the capital at charge stood at K3,679 lakhs and subsequently steadily increased to approximately K4,316 lakhs as of September 30, 1952, as shown in more detail in Table XI–21 (*see p. 265*). The record of capital additions is extremely creditable considering the difficult conditions under which the work has been carried out.

C. EXISTING SYSTEM

1. ORGANIZATION

Burma Railways is a government monopoly operating under the direction of the Union of Burma Railway Board. The staff organization of Railways is shown on Plate 1. Subject to the control of the President of Burma, the Board has the power to "regulate, construct, maintain, and operate the railways in the Union of Burma"; to "undertake other activities necessary or expedient for the proper carrying out of its functions under this Act"; and "shall act on business principles with due regard to the interests of agriculture, industry, commerce and the general public." The general form of organization is consistent with customary railroad practices except that train operations, rates and fares, and commercial activities are under the direction of the Traffic Manager.

2. RAILROAD NET

The various lines and branches of the railway system are shown on the map, Plate 2. Table XI–4 shows the present and past total mileage and the effects of the various forms of damage.

TABLE XI – 4

ROUTE MILEAGE

	Miles
Prewar route mileage	2,058
Mileage in operation March, 1953	1,570
Difference	488
War damage restored but now in insurgent hands	139
War damage restored but more work required to restore damage, by insurrection and work halted, being in unsafe areas	78
War damage not yet restored, line in insurgent hands	215
Abandoned (47) and low priority (9)	56
Total	488

There are five major gaps in the line:

(*a*) The Ava Bridge over the Irrawaddy River near Mandalay, destroyed by combat action in 1942. Steel was ordered in 1948, and the bridge is expected to be reopened for rail and highway traffic by late 1954.

(*b*) The Sittang River Bridge on the Moulmein branch 30 miles east of Pegu, also destroyed by war action, will be replaced at a site about nine miles up river and should be ready for traffic by about 1958.

(*c*) The Daga River Bridge on the Henzada–Bassein line, destroyed by air attack, should be ready for the resumption of traffic in 1954.

(*d*) The Irrawaddy River between Tharrawaw and Henzada has never been bridged and transfers are made by ferry.

(*e*) The Salween River between Martaban and Moulmein has never been bridged. The goods were formerly transferred on barges, and rolling stock by special barge, but destruction of barges has virtually stopped such traffic.

3. TRACK AND BRIDGES

Grades and curvatures are generally minor in degree and extent. Four per cent grades and switchbacks, or ghats, occur on the Lashio and Shwenyaung branches. The Prome–Rangoon–Mandalay main lines are suitable for high speed, heavy tonnage operation. A summary of gradients and curvatures is given in Table XI–5.

TABLE XI – 5

GRADIENTS AND CURVATURE

Road District	*Distance (miles)*	*Ruling Grade (%)*	*Longest Stretch (miles)*
Main Line			
Rangoon–Prome	161	0·33	1·00
Rangoon–Toungoo	166	0·33	1·00
Toungoo–Mandalay	219	0·50	1·40
Branches			
Myohaung–Myitkyina	328	1·66	0·35
Naba–Katha	15	2·00	0·35
Myohaung–Maymyo	40	4·00	1·95
Maymyo–Lashio	138	2·50	2·55
Thazi–Myingyan	70	1·00	1·25
Thazi–Lebyin	38	2·50	1·70
Lebyin–Shwenyaung	60	4·00	3·00
Pyinmana–Taungdwingyi	67	0·80	1·45
Pegu–Martaban	122	0·33	2·00
All other	—	1·00	1·60

EXTENT OF GRADIENTS ON 1,787 ROUTE MILES

Rate of Grade	*Miles of Grade*
Maximum 4%	26·50
Less than 4% to 2%	76·90
,, ,, 2% to 1%	88·46
,, ,, 1% to 0·5%	150·45

CURVATURE CHARACTERISTICS

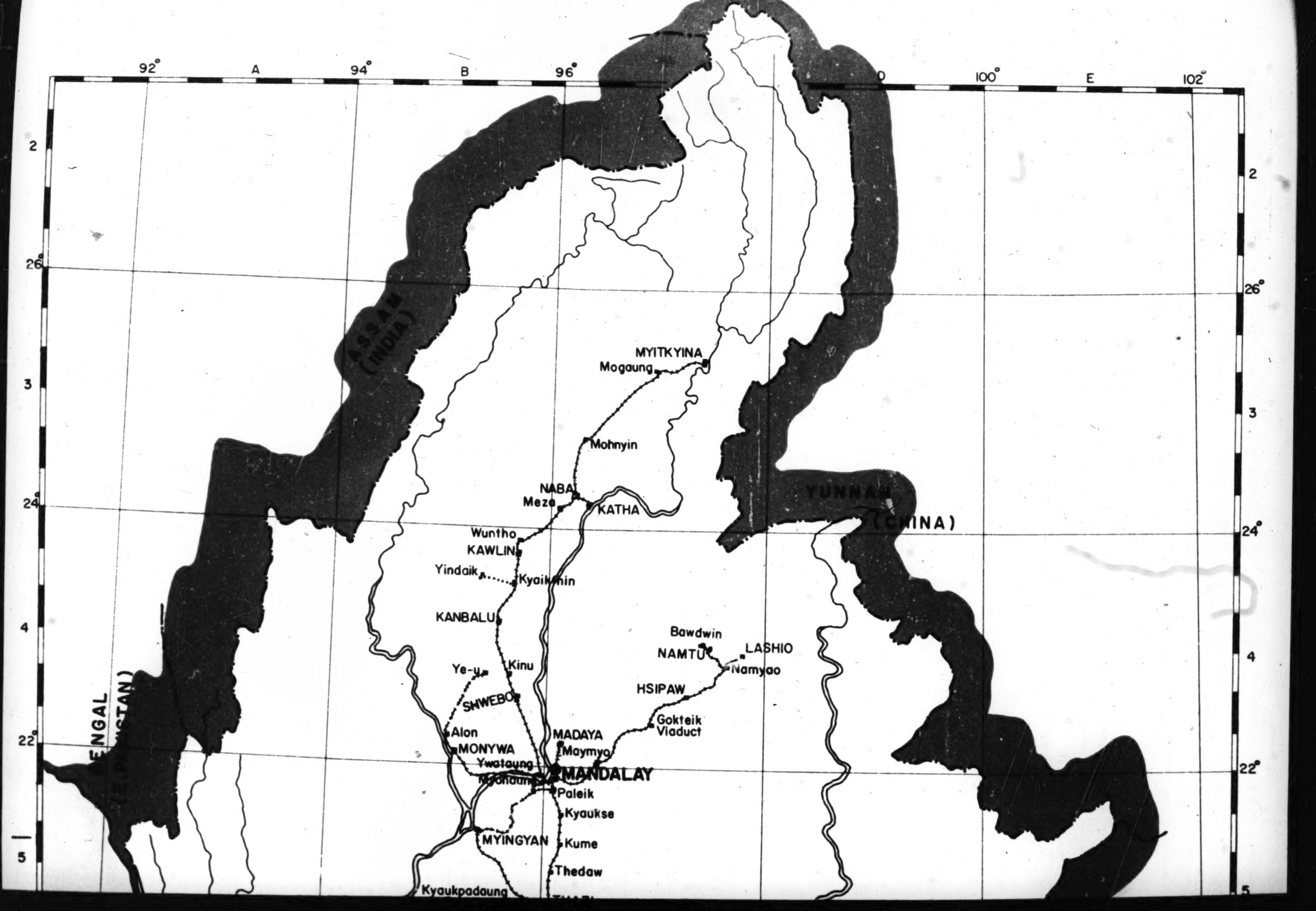
Main line curves do not exceed 4 degrees.
Minimum radius 337·1 ft. or 17 degrees.
Ratio of curved to total line 15·39%.*
Average central angle per mile 37·22 degrees.*

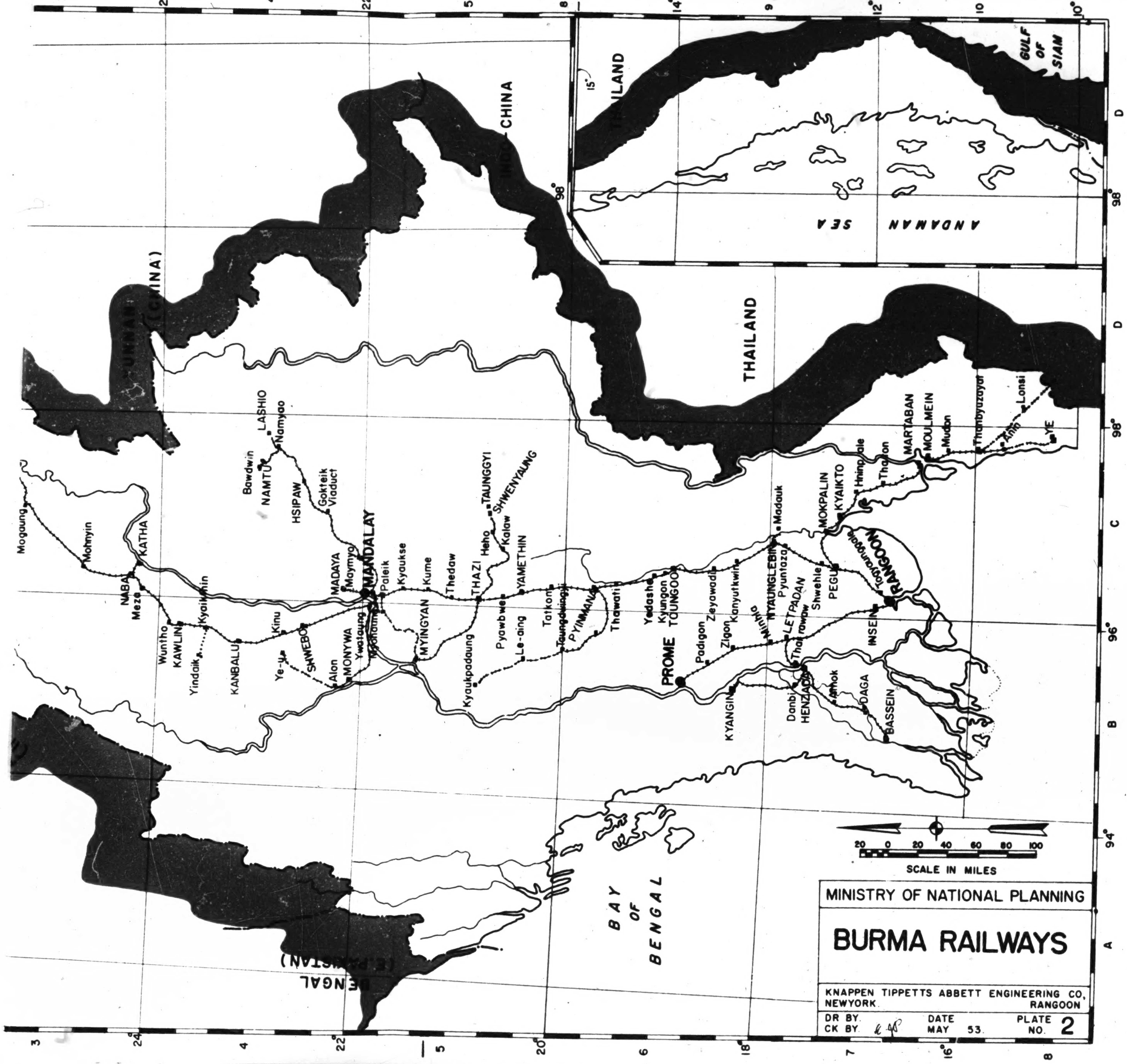
* Largely due to Myitkyina, Lashio and Shwenyaung Branches.

Station and rights-of-way fencing and pedestrian crossings need repair and maintenance at nearly all major stations. The tracks are meter gauge, laid with 50-lb., 60-lb. and 75-lb. rail of conventional tee section. Rails are well anchored and track well ballasted. Sleepers, or cross-ties, will be creosoted in the new treating plant now being erected at Myohaung near Mandalay. Bridges are designed for adequate loadings, but clearances on some of the older structures are restricted.

4. COMMUNICATIONS

The prewar signaling systems are being restored in accordance with the rehabilitation plans prepared in India. Interlocking signals and power-operated


92°
A
94°
B
96°
D
100°
E
102°
2
26°
3
24°
4
22°
5
ASSAM (INDIA)
YUNNAN (CHINA)
BENGAL (E. PAKISTAN)
MYITKYINA
Mogaung
Mohnyin
NABA
Meza
KATHA
Wuntho
KAWLIN
Yindaik
Kyaikthin
KANBALU
Ye-u
Kinu
SHWEBO
Alon
MONYWA
Ywataung
Myohaung
MANDALAY
MADAYA
Maymyo
Paleik
Kyaukse
MYINGYAN
Kume
Thedaw
Kyaukpadaung
Bawdwin
NAMTU
LASHIO
Namyao
HSIPAW
Gokteik Viaduct


YUNNAN (CHINA)
INDO-CHINA
THAILAND
BENGAL (E. PAKISTAN)
BAY OF BENGAL
ANDAMAN SEA
GULF OF SIAM
Mogaung
Mohnyin
KATHA
NABA
Meza
Wuntho
KAWLIN
Kyaikthin
Yindaik
KANBALU
Kinu
SHWEBO
Ye-u
Alon
MONYWA
Ywataung
MADAYA
Maymyo
MANDALAY
Paleik
Kyaukse
Kume
MYINGYAN
Thedaw
THAZI
Heho
Kalaw
TAUNGGYI
SHWENYAUNG
YAMETHIN
Pyawbwe
Kyaukpadaung
Le-aing
Tatkon
Taungdwingyi
PYINMANA
Thawati
Yedashe
Kyungon
TOUNGOO
Zeyawadi
Kanyutkwin
NYAUNGLEBIN
Pyuntaza
Madauk
LETPADAN
Tharrawaw
PROME
Padigon
Zigon
Shwehle
PEGU
MOKPALIN
KYAIKTO
INSEIN
RANGOON
KYANGIN
HENZADA
Danbi
Athok
DAGA
BASSEIN
LASHIO
Namyao
Bawdwin
NAMTU
HSIPAW
Gokteik Viaduct
Hninpale
Thaton
MARTABAN
MOULMEIN
Mudon
Thanbyuzayat
Anin
Lonsi
YE
SCALE IN MILES
20 0 20 40 60 80 100
24°
22°
20°
18°
16°
14°
12°
10°
15°
94°
96°
98°
A
B
C
D

MINISTRY OF NATIONAL PLANNING

BURMA RAILWAYS

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK. RANGOON

DR BY.
CK BY. K.W.
DATE MAY 53.
PLATE NO. 2

switches are in use at Rangoon, and automatic block signals are employed on the Rangoon–Prome line between Rangoon and Kemmendine, about 3½ miles. Yard interlocking plants are located also at seven other stations.

Land-line telegraph communications are installed and maintained by the Telecommunications Department of the Ministry of Transport and Communications. The disruption of land-line operations by insurgents has been partially overcome by radio links between Rangoon and Toungoo, Pyinmana, Yamethin, Thazi, Mandalay and Katha. Forty additional radio stations are being installed at important traffic centers for routine telegraphic business and future emergencies. Traffic cannot be moved efficiently until the communications problem has been solved.

5. YARDS

A marshaling yard is provided at Malagon, in the vicinity of Rangoon, and another is planned for development at Myohaung, the junction of the Lashio, Myitkyina and Ye-U branches. Station yards and belt lines serve Rangoon, and an extensive yard layout serves Mandalay. Yard layouts exist at other stations as well, and are generally adequate.

6. BUILDINGS AND UTILITIES

Both service buildings and housing are being provided by Burma Railways under the present development program. Family housing and facilities for medical attention for about 57,000 persons will eventually be required. The housing program constitutes a large factor in the Railways capital and expense budget. Progress on the rehabilitation or reconstruction of stations at 44 major locations is good.

The water-supply systems were badly damaged by the war and subsequent fighting, but good progress has been made in their restoration and improvement. Electric power requirements, obtained from both public sources and Railways' own plants, in the fiscal year 1951–52 were as follows:

Purchased	2,062,991 kWh	68%
Generated	989,030 kWh	32%
Total	3,052,021 kWh	100%

TABLE XI – 6

LOCOMOTIVE SUPPLY

Class	*Wheel Arrangement*	*Type*	*Weight in Working Order (tons*)*	*Tractive Effort (lbs.)*	*Number on Line*	*Year Built*	*Total Tractive Effort (lbs.)*
GB	2-8/8-2	Garratt	103	41,890	10	1946	418,900
GC	2-8-2/2-8-2	,,	117	41,890	12	1946	502,680
YD	2-8-2	IRS Goods	96	22,108	20	1950	442,160
D	2-8-2	USA ,,	95	20,128	57	1946	1,147,296
YC	4-6-2	IRS Passgr.	98	19,729	10	1948	197,290
ST	2-8-4	Tank-shunt	56	17,613	28	1948–49	493,164
YB	4-6-2	IRS Passgr.	94	16,492	50	1947–48	824,600
					187	(Postwar)	4,026,090
YD	2-8-2	IRS Goods	92	22,108	13	1928–30	287,404
YC	4-6-2	IRS Passgr.	96	19,729	1	1932	19,729
K	4-6-0	Goods	63	17,952	14	1920–25	251,328
KS	4-6-0	,,	61	15,778	21	1905–14	331,338
Jap	2-6-0	Mixed	66	15,300	13	1944	198,900
JS	4-6-0	,,	65	14,187	7	1905–08	99,309
A	4-6-4	Tank-subn.	57	17,952	1	1931	17,952
AS	4-6-4	,, ,,	51	15,778	2	1916	31,556
E	2-6-4	,, shunt	54	15,541	11	1929–30	170,951
M	2-6-2	,, ,,	47	15,541	15	1909–28	233,115
FS	0-6-0	,, ,,	44	11,623	17	1901–03	197,591
F	0-6-0	,, ,,	39	9,685	5	—	48,425
				Grand Total	307		5,913,688

* Tons of 2,240 lbs.

IRS: Indian Railways Standard. USA: USA Army Type.

A new, modern generating plant for Railways purposes has just been completed at Mandalay. Although the current needs are being met, there is a probable requirement totaling 850 kilowatts in the Mandalay area to meet the heavy traffic increases that would be expected to develop by 1957 as a result of the industrial projects proposed for that region. This aspect of the power requirement is further treated in Part VI, Electric Power.

7. SHOPS

There are three principal workshops for construction, repair and maintenance of rolling stock, and for the requirements of the Civil Engineering Department. The main locomotive shop (Plate 3) at Insein, nine miles north of Rangoon on the line to Prome, is a busy and efficiently run facility well adapted to the needs of Burma Railways. The layout of the restored carriage and wagon shop at Myitnge, eight miles south of Mandalay, is shown on Plate 4. The carriage shop is served by a new power plant and has modern woodworking equipment, but needs additional portable power tools. The rebuilt civil engineering workshop in Rangoon needs an additional quota of tools of specialized types for the bridge and rail work required. The new timber-treating plant at Myohaung will serve all wood-treating purposes and will effect considerable long-range economies.

8. ROLLING STOCK

The characteristics of the present complement of 307 locomotives are shown in Table XI–6 (*see p. 259*).

Sixty-eight per cent of the total available tractive effort was built after 1945. The locomotives are well maintained although cannibalization has been necessary to support some of the older types.

TABLE XI – 7

PASSENGER-TRAIN VEHICLES

1941		Class	*1953*	
Units	*Seats*		*Seats*	*Units*
—	1,422	I*	906	—
—	2,734	II*	—	—
—	36,800	III	27,673	—
766	40,956	—	28,579	534
380	—	Miscellaneous	—	171
1,146	—	Total	—	705

* Classes I and II now combined as "Upper" and Class III called "Lower." Some carriages accommodate two classes of traffic.

Passenger vehicles are in drastically short supply as may be seen from Table XI–7.

The 200 new carriages under construction in Rangoon, though equipped with toilets, water, lights and fans, make no provision for passing from carriage to carriage, a serious deficiency from the viewpoint of preventing ticketless travel. Early consideration should be given to remodification of these vehicles to provide this added feature, particularly for the vehicles now under construction. Also, an additional 350 passenger vehicles are urgently needed to alleviate the present unsanitary and indecent crowding.

The supply of goods-train vehicles, even under present depressed traffic levels, is inadequate. Present stocks of such vehicles are listed in Table XI–8.

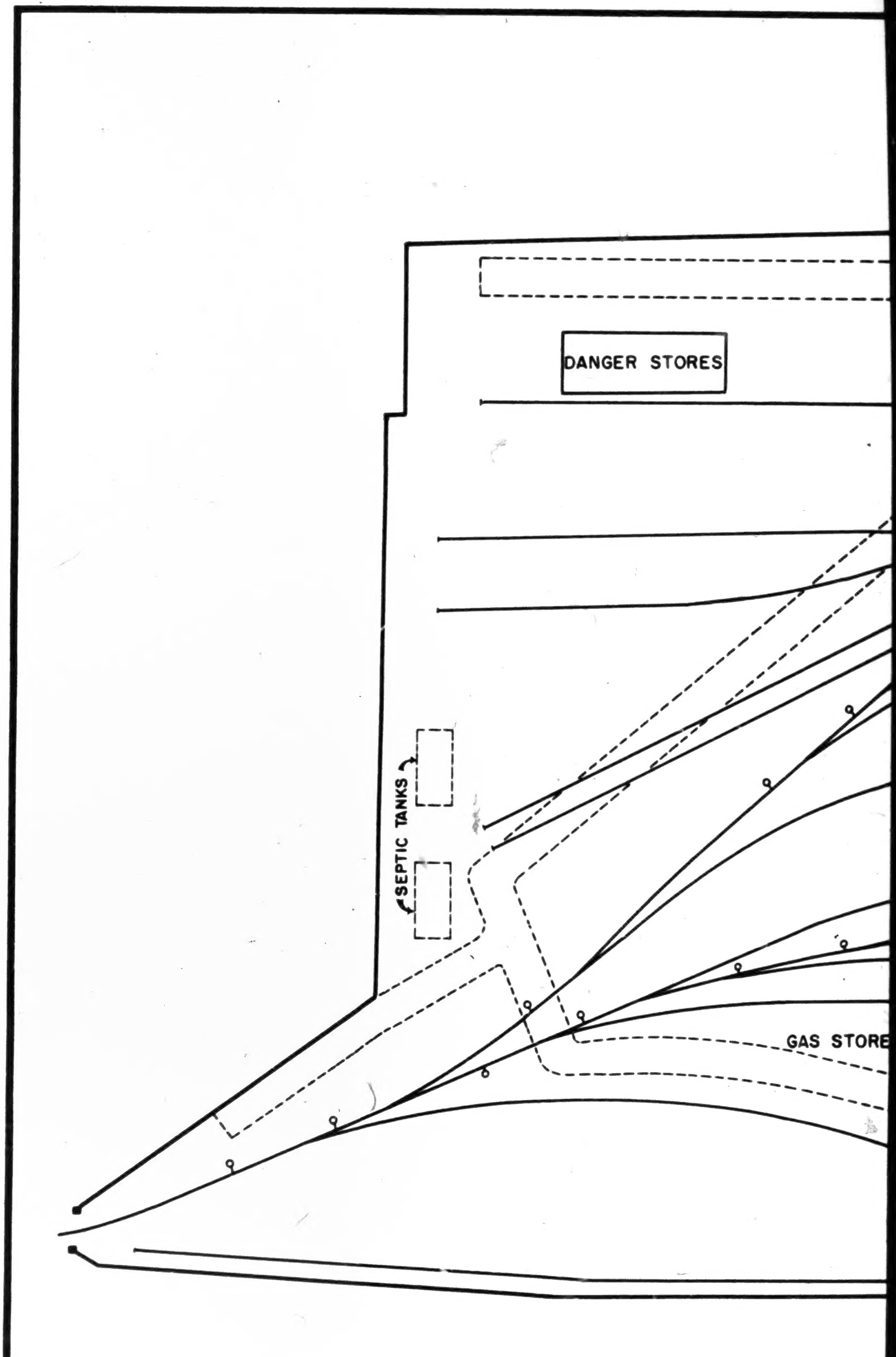
TABLE XI – 8

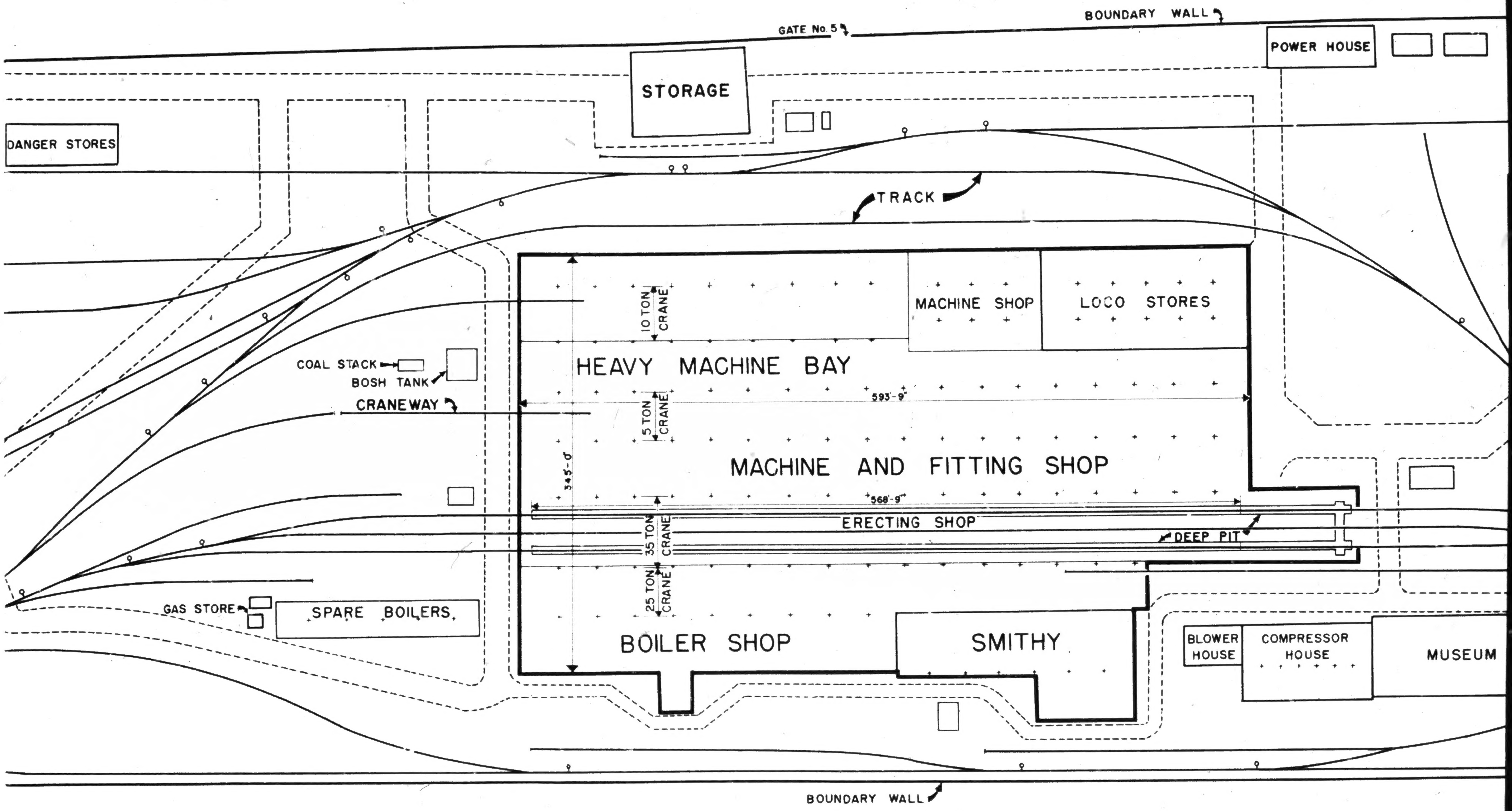
GOODS-TRAIN VEHICLES

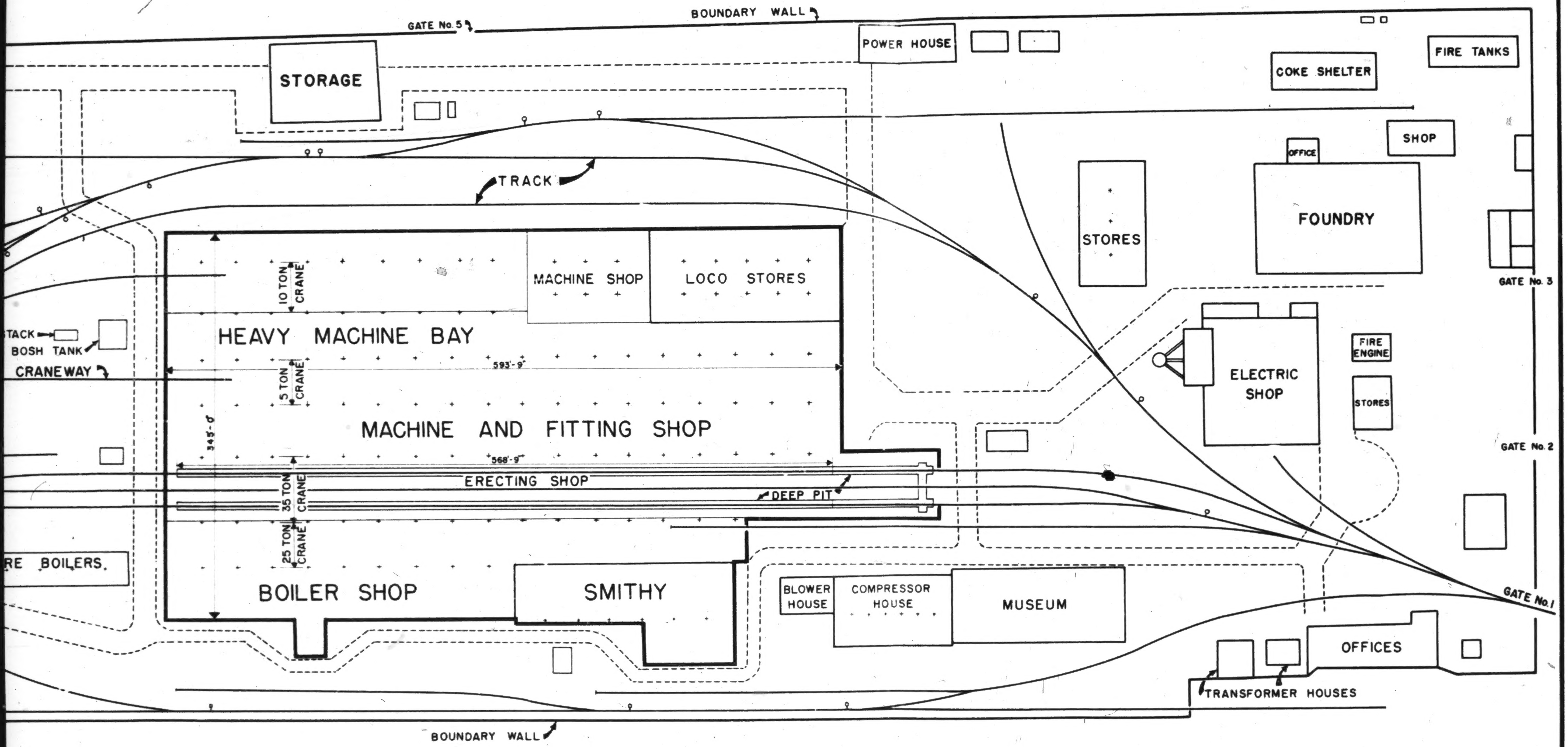
Type of Vehicle	*Average Tare (tons*)*	*Short 4-wheel*	*Bogie 8-wheel*	*Type Total*
A. Goods Wagons				
Covered Goods Wagons	5·45	3,466	—	—
	12·03	—	390	3,856
Open Goods Wagons—High Side	5·01	468	—	—
	9·95	—	152	620
Open Goods Wagons—Low Side	5·31	382	—	—
	10·19	—	66	448
Group Total A		4,316	608	4,924
B. Special Service Vehicles				
Timber or Rail Wagons	4·18	112	—	—
	10·50	—	321	433
Departmental Wagons—Various	5·69	82	—	—
	15·31	—	64	146
Miscellaneous Type Wagons	4·65	76	—	—
	11·29	—	35	111
Tank Wagons—not Petrol	6·53	6	—	—
	15·13	—	15	21
Tank Wagons—Petrol	14·83	—	31	31
Live-stock Wagons	5·32	90	—	90
Brake Vans	11·71	134	—	—
	27·50	—	2	136
All other units, cranes, etc.	—	58	7	65
Group Total B		558	475	1,033
GRAND TOTAL—A, B		4,874	1,083	5,957

* Tons of 2,240 lbs.

The shortage of vacuum brakes on freight vehicles is a serious handicap to efficient operation. The possible requirement for refrigerator cars merits further study. A very rough estimate of total goods service vehicle


DANGER STORES
SEPTIC TANKS
GAS STORE


BOUNDARY WALL
GATE No. 5
POWER HOUSE
STORAGE
DANGER STORES
TRACK
MACHINE SHOP
LOCO STORES
10 TON CRANE
HEAVY MACHINE BAY
COAL STACK
BOSH TANK
CRANEWAY
5 TON CRANE
593'-9"
MACHINE AND FITTING SHOP
345'-0"
568'-9"
ERECTING SHOP
35 TON CRANE
DEEP PIT
25 TON CRANE
GAS STORE
SPARE BOILERS
BOILER SHOP
SMITHY
BLOWER HOUSE
COMPRESSOR HOUSE
MUSEUM
BOUNDARY WALL



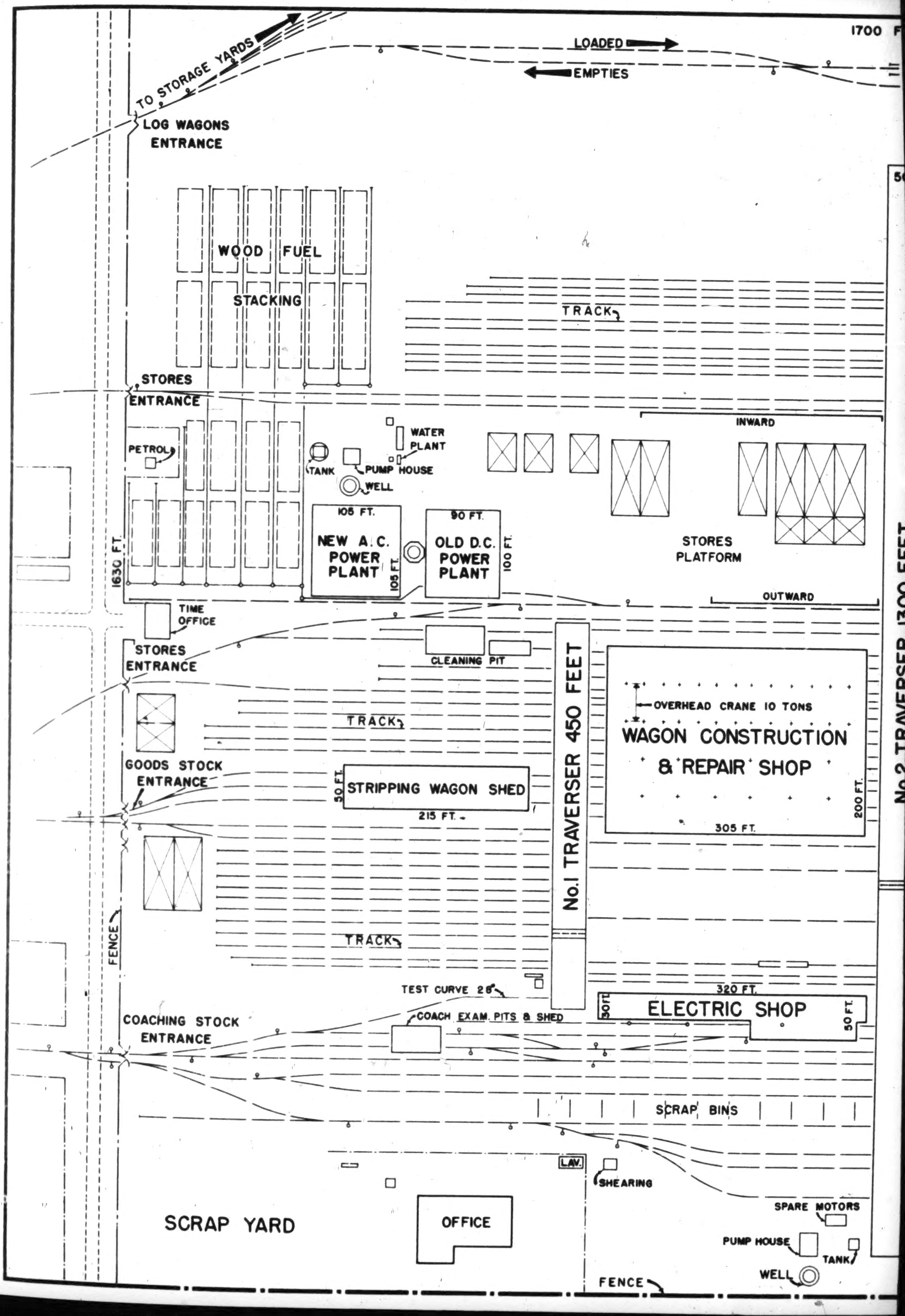
BOUNDARY WALL
GATE No. 5
POWER HOUSE
FIRE TANKS
COKE SHELTER
STORAGE
SHOP
OFFICE
TRACK
FOUNDRY
STORES
MACHINE SHOP
LOCO STORES
10 TON CRANE
GATE No. 3
STACK
BOSH TANK
HEAVY MACHINE BAY
FIRE ENGINE
CRANEWAY
593'-9"
5 TON CRANE
ELECTRIC SHOP
STORES
345'-0"
MACHINE AND FITTING SHOP
GATE No. 2
568'-9"
ERECTING SHOP
35 TON CRANE
DEEP PIT
25 TON CRANE
RE BOILERS.
BOILER SHOP
SMITHY
BLOWER HOUSE
COMPRESSOR HOUSE
MUSEUM
GATE No. 1
OFFICES
TRANSFORMER HOUSES
BOUNDARY WALL

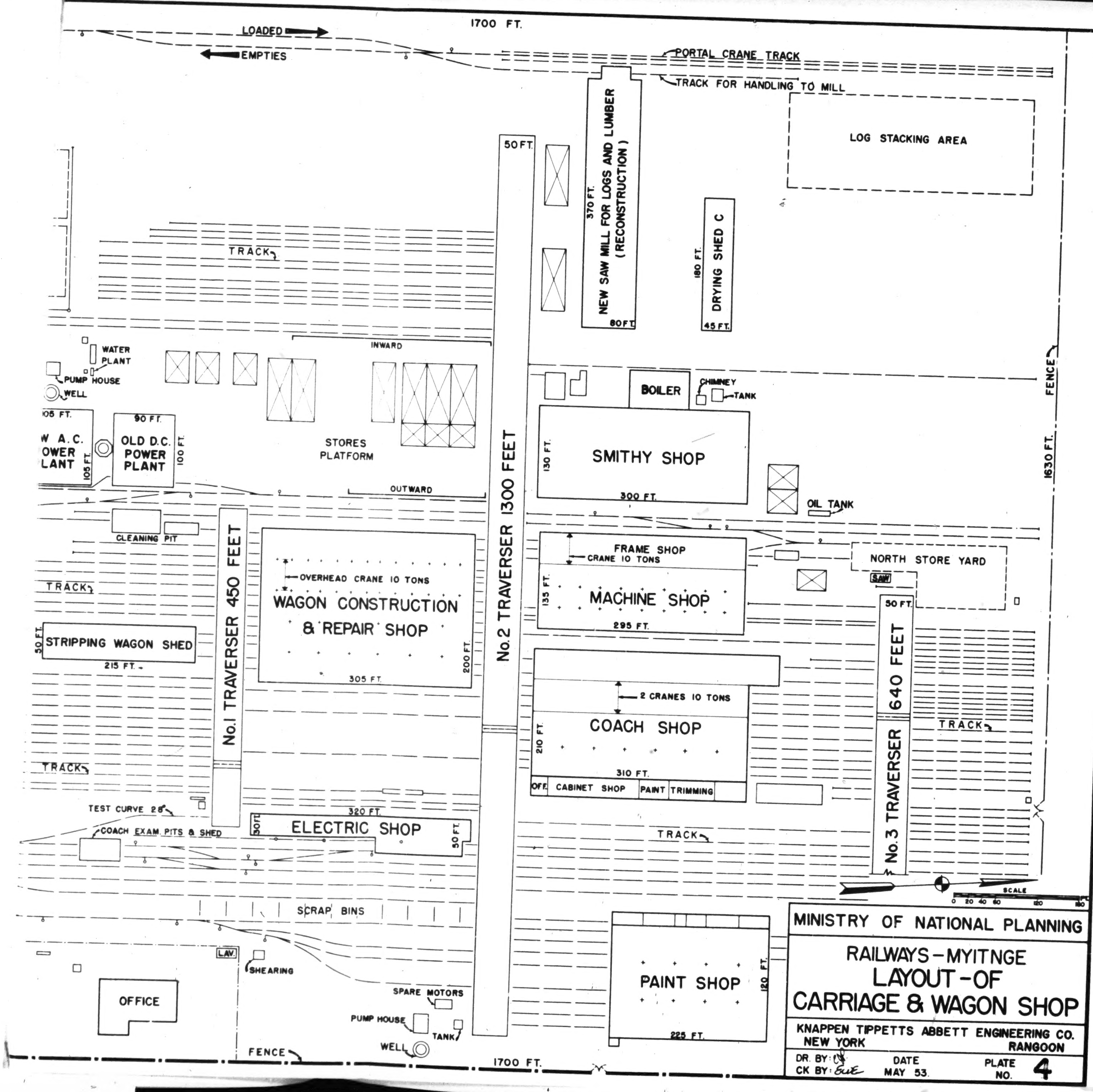
MINISTRY OF NATIONAL PLANNING

RAILWAYS – INSEIN
LOCOMOTIVE SHOPS

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY:	DATE	PLATE
CK. BY: EWE	MAY 53.	NO 3


1700 F
TO STORAGE YARDS
LOADED
EMPTIES
LOG WAGONS ENTRANCE
WOOD FUEL STACKING
TRACK
STORES ENTRANCE
INWARD
PETROL
WATER PLANT
TANK
PUMP HOUSE
WELL
105 FT.
NEW A.C. POWER PLANT
105 FT.
90 FT.
OLD D.C. POWER PLANT
100 FT.
STORES PLATFORM
OUTWARD
1630 FT.
TIME OFFICE
STORES ENTRANCE
CLEANING PIT
No.1 TRAVERSER 450 FEET
OVERHEAD CRANE 10 TONS
WAGON CONSTRUCTION & REPAIR SHOP
200 FT.
305 FT.
TRACK
GOODS STOCK ENTRANCE
50 FT.
STRIPPING WAGON SHED
215 FT.
FENCE
TRACK
TEST CURVE 2°
320 FT.
30 FT.
ELECTRIC SHOP
50 FT.
COACHING STOCK ENTRANCE
COACH EXAM. PITS & SHED
SCRAP BINS
LAV.
SHEARING
SCRAP YARD
OFFICE
SPARE MOTORS
PUMP HOUSE
TANK
WELL
FENCE
No.2 TRAVERSER 1300 FEET


1700 FT.
LOADED
EMPTIES
PORTAL CRANE TRACK
TRACK FOR HANDLING TO MILL
LOG STACKING AREA
NEW SAW MILL FOR LOGS AND LUMBER (RECONSTRUCTION)
370 FT.
80 FT.
DRYING SHED C
180 FT.
45 FT.
50 FT.
TRACK
INWARD
WATER PLANT
PUMP HOUSE
WELL
05 FT.
W A.C. POWER LANT
105 FT.
90 FT.
OLD D.C. POWER PLANT
100 FT.
STORES PLATFORM
OUTWARD
No.2 TRAVERSER 1300 FEET
BOILER
CHIMNEY
TANK
FENCE
1630 FT.
SMITHY SHOP
130 FT.
300 FT.
OIL TANK
CLEANING PIT
No.1 TRAVERSER 450 FEET
OVERHEAD CRANE 10 TONS
WAGON CONSTRUCTION & REPAIR SHOP
305 FT.
200 FT.
FRAME SHOP
CRANE 10 TONS
MACHINE SHOP
135 FT.
295 FT.
NORTH STORE YARD
SAW
50 FT.
TRACK
STRIPPING WAGON SHED
50 FT.
215 FT.
2 CRANES 10 TONS
COACH SHOP
210 FT.
310 FT.
OFF.
CABINET SHOP
PAINT
TRIMMING
640 FEET
No.3 TRAVERSER
TRACK
TRACK
TEST CURVE 28°
COACH EXAM. PITS & SHED
320 FT.
ELECTRIC SHOP
30 FT.
50 FT.
TRACK
SCALE
0 20 40 60 120 180
SCRAP BINS
LAV.
SHEARING
OFFICE
SPARE MOTORS
PUMP HOUSE
TANK
WELL
PAINT SHOP
120 FT.
225 FT.
FENCE
1700 FT.

MINISTRY OF NATIONAL PLANNING

RAILWAYS – MYITNGE
LAYOUT – OF
CARRIAGE & WAGON SHOP

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK
RANGOON

DR. BY: CJ
CK BY: GuE
DATE
MAY 53.
PLATE
NO. 4

requirements is given in the accompanying Table XI-9.

TABLE XI - 9

GOODS VEHICLE REQUIREMENTS

Type	*1955–56*	*1957–58*	*1959–60*
Covered Goods Wagons	5,900	6,200	6,400
Open Goods Wagons	1,700	2,030	2,200
Timber Wagons	560	630	700
Live Stock	600	700	750
Miscellaneous, Tanks, etc.	510	540	820
Total	9,270	10,100	10,870

D. CURRENT OPERATIONS

1. TRAIN MOVEMENTS

Trains are moved by several variants of the basic English system of absolute station-to-station block. Each station master passes the train to the next block after communicating with the station ahead to assure that no opposing train will be forwarded. With the failure of communications, emergency measures are frequently required. The trains are normally moved close to schedule, but passengers are sometimes returned to their starting points to await the repair of sabotaged lines. Extra trains are originated by the Traffic Department, but after leaving the terminal are moved by the various station masters. At stations without interlocking plant, from one to four jemadars on the station master's staff clear trains over the switching point switches. Train crews normally consist of three men, the engine driver, the fireman and the guard. These crews are on the staff of the chief mechanical engineer, but take their operating directions from the local Traffic Department. The guard is a traffic department employee.

Maintenance and construction are supervised by the chief engineer with the advice of the consulting engineers in London. Rehabilitation and maintenance of rolling stock, floating equipment and mechanical goods are supervised by the chief mechanical engineer.

2. PERSONNEL

A retirement system limits the turnover of employees. With the loss of trained specialists when Burma became independent, it became necessary to establish training courses to provide technical replacements. Selected employees are sent to the United States, Great Britain and Canada under foreign aid programs for advanced technical training. It should be noted that reductions in force achieved by the introduction of efficient methods and equipment can only be realized at the rate consistent with normal attrition or the absorption of personnel in expanded services. Medical services are provided to 19,000 employees and their families under the direction of a chief medical officer. Preventive measures are effective and outbreaks of contagious diseases are met with prompt and vigorous measures. The extent of medical treatment is summarized in Table XI-10.

TABLE XI - 10

MEDICAL TREATMENT CASES

Group	*1951–52*		
	Males	*Females*	*Total*
Railway Employees	77,761	573	78,334
Families of Employees	48,713	55,337	104,050
Non-railway Patients	4,856	3,216	8,072
Total	131,330	59,126	190,456

3. TRAFFIC AND EARNINGS

The distribution of traffic, the sources of goods traffic, earnings, and rates charged for selected com-

TABLE XI - 11

DISTRIBUTION OF TRAIN MILES

(Prewar and Postwar)

Class of Trains	*Train Miles and Per cent of Total*	
	1940–41	*1951–52*
1. Passenger Trains*	1,442,000— 19%	551,200— 25%
2. Mixed Trains†	3,988,000— 53%	1,043,400— 47%
3. Passenger and Mixed Total	5,430,000— 72%	1,594,600— 72%
4. Goods Trains—Main Line	1,407,000— 19%	525,900— 24%
5. Goods Trains—Branch Line	707,000— 9%	97,700— 4%
6. Goods Trains—Total‡	2,114,000— 28%	623,600 — 28%
7. Total Commercial Traffic	7,544,000—100%	2,218,200—100%
8. Departmental Trains	386,000	474,900

* 99% of total passenger-train vehicle miles in 1951–52 were run on main line, Prome–Rangoon–Mandalay, including 22% run in Rangoon suburban service.

† Approximately two thirds of mixed-train vehicle miles accumulated on branch lines. Mixed trains averaged 88% carriages, 1951–52.

‡ Goods-train vehicle miles accumulated in 1951–52 were 97% on main line.

modities are shown in Tables XI-11 through XI-15. Any conclusions that might be drawn from an examination of the trends disclosed by these tables should take into account the following factors:

(*a*) The higher passenger earnings of the past four years are due to increases in rates rather than volume of traffic.

TABLE XI – 12

PASSENGER TRAFFIC

Year	*Passengers Carried* Upper Class (000)	Lower Class (000)	Total (000)	*Earnings* Passenger Total (K lakhs)	Passenger Mile (pyas)	Average Haul (miles)
1929–30	671	32,543	33,214	NA	NA	NA
1930–31	591	28,271	28,862	128·31	2·03	22·0
1931–32	417	22,431	22,848	97·55	1·87	22·8
1932–33	330	20,879	21,209	93·20	1·88	23·4
1933–34	269	20,061	20,330	86·50	1·90	22·4
1934–35	279	20,457	20,736	88·36	1·87	22·7
1935–36	288	20,271	20,559	95·91	1·98	23·0
1936–37	281	19,992	20,273	95·99	1·97	23·9
1937–38	247	19,156	19,403	90·89	1·96	23·9
1938–39	250	18,670	18,920	83·68	1·91	23·1
1939–40	233	18,557	18,810	88·58	1·97	23·9
1940–41	235	19,523	19,758	98·79	1·97	25·2
1941–45			WAR PERIOD			
1945–46	NA	NA	NA	NA	NA	NA
1946–47	21	8,214	8,235	138·82	5·40	31·2
1947–48	32	10,117	10,149	134·41	4·48	29·6
1948–49	6	4,413	4,419	32·53	4·38	16·8
1949–50	5	6,592	6,597	50·18	4·72	16·1
1950–51	15	9,805	9,820	95·23	4·61	21·1
1951–52	17	11,789	11,806	115·07	4·56	21·2

Source: Railways Annual Reports or other records.

Notes: 1 Kyat is of same value as former Rupee.
1 Pya is 1/100th Kyat.
1 Lakh equals 100,000.
NA: records not available.

(*b*) The restoration of normal train service, faster schedules, and improved facilities would undoubtedly attract to railways much of the passenger traffic lost during the disruption of service.

(*c*) The proposed agricultural and industrial developments with expected improvements in the standard of living will further increase the potential passenger traffic.

(*d*) Correction of the abuses of ticketless travel should result in a substantial increase in revenues.

(*e*) With inclusion of departmental traffic, which is handled at commercial rates, the figures for gross earnings unduly distort the goods revenue totals as an index of profits.

TABLE XI – 13

SOURCES OF GOODS TRAFFIC

Group	*Percentage of Total Tonnage* 1948–49	1949–50	1950–51	1951–52
Agriculture	44·2	45·6	44·0	43·2
Mines	7·2	6·6	12·8	8·8
Forest	8·0	9·8	12·3	13·0
	59·4	62·0	69·1	65·0
Railways Departmental	27·6	28·4	21·3	23·5
All Others	13·0	9·6	9·6	11·5
	100·0	100·0	100·0	100·0

TABLE XI – 14

GOODS TRAFFIC

(Including Railways Departmental)

Year	Tons Carried (000)	*Earnings* Total (K lakhs)	Ton-mile (pyas)	Average Haul (miles)
1929–30	NA	317·32	NA	NA
1930–31	4,945	280·00	3·98	142·3
1931–32	3,975	251·26	4·20	150·5
1932–33	3,449	217·41	4·08	154·6
1933–34	4,021	252·18	4·05	155·4
1934–35	4,175	265·50	3·92	162·1
1935–36	3,983	249·59	3·88	161·5
1936–37	3,857	254·35	3·92	167·6
1937–38	3,970	253·48	3·80	167·9
1938–39	4,057	263·89	3·78	171·9
1939–40	4,001	276·59	4·04	171·4
1940–41	4,031	309·31	4·37	175·6
1941–45		WAR PERIOD		
1945–46	NA	NA	NA	NA
1946–47	1,863	336·69	10·57	171·2
1947–48	2,108	315·20	8·45	181·5
1948–49	784	103·91	10·42	127·4
1949–50	833	110·66	19·25	67·2
1950–51	1,362	194·72	15·90	89·9
1951–52	1,651	257·21	14·32	108·6

Source: Railways Annual Reports and other records or computed.

Notes: 1 Kyat is of same value as former Rupee.
1 Pya is 1/100th Kyat.
1 Lakh equals 100,000.
NA: records not available.

(*f*) The decline in goods traffic shown in Table XI-14 is attributable to the effects of insurgency and lowered production.

The traffic rates are set by the Traffic Department subject to the approval of the Ministry of Transport and Communications and of the President. Since about 70% of the traffic originates with government agencies, and since competition in transport service is limited to the Government Inland Waterways and the Union of Burma Airways, together with a minor volume of privately owned highway transport, the rate structure is relatively free of the pressure of competition.

Passenger and goods rates were increased in October 1945, in April 1946, in October 1946, by surcharges of 25%, 50% and 100% respectively. In August 1949 basic rates for both goods and passengers were also increased. Further increases are being sought. Nevertheless, on many important commodities, the present rates, including their 100% surcharge, are less than rates charged by Inland Water Transport. As the almost universal experience elsewhere is that water rates may be lower than rail rates, the condition in Burma suggests either that the rail rates are below the standard level or that the water rates are unnecessarily high. It should also be noted from Table XI–15 that the tariffs on widely different commodities are equal, a practice not normally followed in other countries. These two conspicuous incongruities in the rate structure serve to emphasize the requirement for a thoroughly competent and experienced transport commission that can be charged with the analyzing and establishing of rates consistent with potential traffic and with the costs of operation. Further reference to this subject is made in Chapter X, Transportation System. For a rough approximation of the adequacy of the present rates, it may be noted from Table XI–16 that in the year 1951–52 an increase of about 20% of the gross earnings would have been required to eliminate the recorded loss.

TABLE XI – 15

COMPARISON OF RATES SELECTED COMMODITIES VIA RAILWAYS AND INLAND WATER TRANSPORT

(kyats/100 viss)

Commodity	Agency	Rangoon to Myingyan	Rangoon to Mandalay	Rangoon to Monywa
Cement	BR	6·500	6·687	8·250
	IWT	9·187	10·375	10·000
Rice	BR	6·500	6·687	8·250
	IWT	10·750	12·250	11·750
Grains, Pulses	BR	6·500	6·687	8·250
	IWT	6·125	6·937	6·687
Sugar	BR	9·250	9·437	11·625
	IWT	10·750	12·250	11·687
Salt	BR	6·500	6·687	8·250
	IWT	9·250	10·500	10·000
Distance by Rail-miles		376	385	457

Source: Resolution of Railway Board, July 5, 1949.

TABLE XI – 16

EARNINGS, EXPENSES, DEPRECIATION, INTEREST, PROFIT OR LOSS

Fiscal Years 1929–30 to 1951–52
(In lakhs)

Year	*Gross Earnings (K)*	*Direct Working Expenses (K)*	*Depreciation (K)*	*Railway Net Earnings (K)*	*Interest on Debt (K)*	*Profit or Loss (−) (K)*
1929–30	492.39	259.60	48.28	184.51	158.80	25.71
1930–31	428.79	263.67	51.72	113.40	158.96	− 45.56
1931–32	380.90	233.45	52.64	94.81	160.96	− 66.16
1932–33	355.74	222.11	53.44	80.19	150.58	− 70.39
1933–34	376.70	227.84	55.28	93.58	154.53	− 60.95
1934–35	389.29	233.89	53.36	102.04	150.22	− 48.18
1935–36	373.39	227.27	58.38	87.74	146.72	− 58.99
1936–37	383.07	208.72	58.19	116.16	141.90	− 25.74
1937–38	374.48	206.86†	57.82	109.80	120.12	− 15.55
1938–39	374.82	208.50†	57.65	108.67	122.39	− 13.72
1939–40	392.11	211.11†	57.57	123.43	120.89	2.54
1940–41	438.63	215.40†	57.19	166.04	120.54	45.50
1941–45			WAR PERIOD			
1945–46	300.19	213.08†	57.53	29.57	121.32	− 91.74
1946–47	509.34	348.82†	58.50	102.01	83.17	18.84
1947–48	486.46	430.24†	69.08	− 12.86	156.84	− 169.69
1948–49	140.93	390.19†	85.63	− 334.90	122.34	− 457.23
*1949–50	204.31	373.13†	61.29	− 230.71	39.04	− 269.75*
*1950–51	337.21	409.00†	64.93	− 136.72	81.88	− 218.60*
*1951–52	526.70	454.07†	68.60	4.03	116.36	− 112.33*

Source: Railways Annual Reports prewar years.

Notes: Postwar figures furnished March 1953 by controller.
1 Lakh equals 100,000.
* Last three years provisional subject to revision.
† Includes net effect certain minor interest items not strictly working expenses.

4. EARNINGS, EXPENSES AND INCOME

The financial record given in Table XI–16 reflects the influence of the depression of 1930–31, the Burma Road traffic of 1940–41, the war, and postwar insurgent conditions.

The high ratio of expense to revenue shown for 1947–51 includes the cost of repairing damages resulting from insurgent depredations. The postwar depreciation charges through 1948–49 and interest charges through 1947–48 result from the insistence of the pre-independence Government upon basing the depreciation on the prewar capital at charge, notwithstanding that half the physical assets had been destroyed during hostilities. A reduction in capital at charge to cover war losses was finally booked in 1948–49 after Independence.

Personnel costs (Table XI–17) will probably continue to increase. Material costs (Table XI–18) are rising faster than personnel costs.

New sources of fuel are needed, and tests have been made with Kalewa coal which may have to be processed into briquettes before it can be used in locomotives. Tests are also under way as to the feasibility of using fuel oil in locomotives. Various fuel statistics are given in Table XI–19.

TABLE XI – 17

PERSONNEL AND WAGE COSTS

Year	Route Miles of Road*	Average Number of Employees	Wages (K lakhs)	Cost Living Allow. (K lakhs)	Total (K lakhs)	Average per Employee (K)	Per cent Working Expenses (†)
1937–38	2,060	22,162	131·77	None	131·77	595	63
1938–39	2,059	21,906	129·42	,,	129·42	590	62
1939–40	2,059	21,851	128·41	,,	128·41	588	61
1940–41	2,058	21,901	129·00	,,	129·00	589	60
1941–45				WAR PERIOD			
1945–46	NA	NA	NA	NA	NA	NA	NA
1946–47	1,777	24,362	132·00	120·00	252·00	1,035	72
1947–48	1,777	22,905	156·00	97·00	253·00	1,105	59
1948–49	1,771	21,232	153·00	114·00	267·00	1,255	68
1949–50	1,771	19,131	110·00	131·00	241·00	1,260	64
1950–51	1,787	18,750	148·00	112·00	260·00	1,386	64
1951–52	1,787	19,121	152·00	115·00	267·00	1,395	54

Source: Railways Annual Reports and other records or computed.

* Postwar route miles shown not all in operation in years shown.

† Based on working expenses excluding depreciation.

TABLE XI – 18

COSTS OF SELECTED MATERIALS

Item		1941 (K)	1947 (K)	1952 (K)
Rail, Rangoon	ton	143	290	949
Structural Steel	,,	221	325	848
Bridge Girders	,,	400	516	727
Indian Coal	,,	21	60	96
Lumber Squared	,,	300	500	1,000
Bricks	100	25	80	58
Cement	ton	50	71	168
Ballast at Quarry	100 cu. ft.	8	38	40
Sleepers Average	each	2½	7	7
Sleepers Switch	ton	85	245	270
G.I. Sheets	,,	440	383	1,453

Source: Railways.

Notes: All tons 2,240 lbs. Duty included on imported items.

TABLE XI – 19

LOCOMOTIVE FUEL

Year	Coal Used	Wood on Coal Basis (tons)*	Total on Coal Basis (tons)*	Engine Miles Run (000)	Lbs. Coal per Engine Mile	Gross Ton-miles Run* (millions)	Lbs. Coal per 1,000 GTM*	Cost Ton Indian Coal Rangoon (K)
1937–38	176,946	4,112	181,058	9,282	44	2,510	162	17.4
1938–39	180,391	4,342	184,733	9,525	43	2,569	161	18.7
1939–40	184,859	14,249	190,558	9,643	44	2,621	163	18.6
1940–41	191,614	15,648	197,872	9,973	44	2,672	166	21.1
1941–45				WAR PERIOD				
1946–47	76,166	11,889	88,055	3,165	62	1,078	183	60
1947–48	94,540	20,517	115,057	4,076	63	1,252	206	68
1948–49	34,841	8,671	43,511	1,625	60	NA	NA	70
1949–50	26,770	19,923	46,693	1,803	58	328	319	69
1950–51	52,313	45,689	98,002	3,214	68	661	332	75
1951–52	83,140	30,751	113,891	3,731	68	827	308	90

Source: Railways Annual Reports.

Notes: Gross ton-miles includes weights of locomotives, trailing loads in freight and passenger service and departmental trains.
Wood conversion basis 187·5 cubic feet piled wood equivalent to 1 ton of coal.

* All tons and ton-miles based on long ton of 2,240 lbs.

Reports and accounting practices will require basic changes if Management and Government are to be accurately advised as to Railways' fiscal affairs. The recently published Annual Reports are completely silent as to departmental expenditures, depreciation, interest and other vital information. Corrections in figures are not carried statistically through to derived totals and tables. Changes are still being made in old accounts. Table XI–20 illustrates the inconsistencies in various reports.

5. CAPITAL AT CHARGE AND DEBT

Table XI–21 shows the record of postwar additions to capital at charge, adjustment for war losses, and the investment in railway plant or capital at charge through 1951–52.

TABLE XI – 20

VARIATIONS IN RAILWAYS RECORDED EARNINGS, EXPENSES, INTEREST AND INCOME

Account and Source	*1946–47* *(K)*	*1947–48* *(K)*	*1948–49* *(K)*	*1949–50* *(K)*	*1950–51* *(K)*	*1951–52* *(K)*
Gross Earnings (in lakhs)						
Annual Report—original issues	494.19P (Table X – 7)	466.59 (Table X – 8)	158.3 (Table X – 8)	194.1P (Table X – 8)	336.69P (Table X – 8)	497.35P
Annual Report—subsequent issues	494.19 (1947–48)	466.59 (1948–49)	160.6 (1949–50)	202.1 (1950–51)	336.7P (1951–52)	—
Genl. Mgr.'s Rate Study 1952	504.00	483.00	138.00	155.00	337.00	—
Controller June 12, 1952	504.29	483.14	138.39	155.29P	337.21P	—
Budget 1952–53 marked "Actual"	—	—	—	164.39	326.06	—
Controller March 23, 1953	509.34	486.46	140.93	204.31P	337.21P	526.70P
Working Expenses (in lakhs) (excluding depreciation)						
Annual Reports	498.90	—	—	—	—	—
Genl. Mgr.'s Rate Study 1952	347.00	428.00	388.00	292.00P	414.00P	—
Controller March 23, 1953	348.83	430.23	390.19	373.72P	409.01P	454.07P
Interest (in lakhs)						
Annual Reports—No information	—	—	—	—	—	—
Controller June 12, 1952	86.41	159.59	125.09	112.31P	114.63P	—
Controller March 23, 1953	83.17	156.84	122.34	39.04P	81.88P	116.36P
Profit and Loss (in lakhs)						
Annual Reports	43.12	—	—	—	—	—
Genl. Mgr.'s Rate Study 1952	17.00	– 156.00	– 455.00	– 317.00	– 262.00	—
Controller June 12, 1952	18.84	– 169.69	– 457.23	– 312.69P	– 270.86P	—
Controller March 23, 1953	18.84	– 169.69	– 457.23	– 269.74P	– 218.60P	– 112.33P

P indicates Provisional subject to change at time issued. 1 lakh equals 100,000.

TABLE XI – 21

ADDITIONS TO AND CAPITAL AT CHARGE

Period	*Net Additions during Year (K)*	*Capital at Charge End of Year (K)*	*Basis of Capital at Charge*
As of October 1, 1945	—	34,51,72,637	Prewar
Additions during 1945–46	58,08,177	35,09,80,814	,,
Additions during 1946–47	6,35,22,522	41,45,03,336	,,
Additions during 1947–48	9,92,73,951	51,37,77,287	,,
Deductions war damage	– 17,86,95,686	—	
Additions during 1948–1949	3,26,84,640	36,77,66,241	Postwar
Additions for 1949–50	2,18,11,757*	38,95,78,998*	,,
,, ,, 1950–51	2,20,00,000*	41,15,78,998*	,,
,, ,, 1951–52	2,00,00,000†	43,15,78,998†	,,

Source: Controller Railways Accounts.

* Provisional subject to adjustment. † Estimated.

Interest is accrued on the full capital at charge, on ways and means advances made by Government to cover deficits, and on other debts. All monies received from any source by the Board are required to be credited to the "Railway Board Fund." However, an extraordinary stipulation that Railways must pay back therefrom all accumulated advances for the four years preceding October 1, 1952, has made Railways dependent upon ways and means advances. Since Railways is running continual deficits, the final effect is to make it again dependent upon the general government budget.

6. REHABILITATION

Despite the many difficulties confronting Railways, great progress has already been made in rehabilitating works damaged by the war and by insurgents. The Management's present program for further restorations and improvement is condensed in Table XI-22 (*see p. 266*). The estimated costs shown are the Management's and would in some cases be insufficient. Some of the work covered has been accomplished.

TABLE XI – 22

PROGRAM OF RESTORATION AND IMPROVEMENTS

	Estimated costs (in K lakhs)	
Civil Engineering Works—Part 1		
1. *Bridges*, including Sittang, Daga, Waw Mu Valley, Mogaung and completion of Ava Bridge	376·94	376·94
2. *Permanent Way*, rail renewals, track restorations, track improvements as shown in detail in Table XI–22a	947·87*	
3. *Station Buildings*, Prome, Shwebo, complete Rangoon, and 120 wayside stations	47·00	
4. *Staff Quarters* to complete one unit per man	187·58	
5. *Signals and Interlocking*, including through service by radio and restoration of station to station train operating wires	23·10	
6. *Fencing at Stations* and between	91·75	
7. *Watering Facilities*, locomotives and trains	33·00	
8. *Station Machinery*, miscellaneous	8·00	
9. *Locomotive Running Sheds*, Carriage and Wagon Sheds	11·00	
10. *Insein and Myitnge Shops*, completion of restoration and improvements	16·10	
11. *Service Buildings*, miscellaneous	32·17	1,397·57
Total Civil Engineering Works		1,774·51*
Mechanical Works and Rolling Stock—Part 2		
12. *Passenger Rolling Stock*		
(*a*) 50 Upper Class Bogie Coaches	68·00	
(*b*) 85 Lower Class ,, ,,	29·50	
(*c*) 5 Upper Class ,, ,, —rebuilds	2·58	
(*d*) 27 Lower Class Bogie Coaches—rebuilds	8·26	
(*e*) 86 New Coaches from India—completion	7·50	
(*f*) 24 Inspection Coaches—rebuilds	6·00	
(*g*) Electric Equipment for carriages	62·00†	183·84
13. *Goods, Timber and Cattle Wagons*		
(*a*) 200 Timber Wagons—New Bogies	84·00	
(*b*) 100 ,, ,, —New 4-wheel	20·00	
(*c*) 2,000 Goods Wagons—New Covered 4-wheel	270·00	
(*d*) 500 Cattle Wagons—New 4-wheel	20·00	
(*e*) 100 ,, ,, —rebuilds	4·00	
(*f*) 6,300 Rolled-steel Wheels	15·00†	413·00
14. *Locomotives*		
(*a*) Diesel-electric Locomotives (6)‡	42·00	
(*b*) Locomotive Boilers (20)—replacements	12·00†	54·00
Total Mechanical Works and Rolling Stock		650·84†
15. Grand Total of Program		2,425·35†

* Part of the cost of item 2 being contributed by US TCA to extent of K12·82 lakhs, reducing total of civil engineering works to K1,761·69 lakhs. May be modified if CTC signals installed.

† Part of the cost of these items contributed by US TCA, amounting to K18·62 lakhs for the mechanical items and aggregating for all program items K31·44 lakhs, reducing the total cost of the entire program to K2,393·91 lakhs.

‡ Initial order for test experience.

All estimated costs are Railways figures except TCA items noted.

TABLE XI – 22A

DETAIL OF ITEM 2 RESTORATION AND IMPROVEMENT PROGRAM

	Item 2 Permanent Way Work	*Estimated costs (K. lakhs)*	
A.	Lay new 75-lb. rail and fastenings, switches, 10% sleeper renewals, Kanyutkwin–Mandalay and Insein–Prome, releasing 60-lb.	415 miles	543·80*
B.	Relay worn 50- and 60-lb. rail on Ywataung–Myitkyina line with relayer 60-lb. rail from Item 1, sleeper renewals 10%.	182 miles	10·00
C.	Track restorations, other branch line rail renewals in part, Danbi–Kyongin, Kalewthut–Ye, Lewe–Kyaukpadaung, Myingyan–Tada U, Meiktila–Myingyan, Ywataung–Ye U, Sittang deviation line, station-yard rail renewals	572 miles	200·35
D.	Ballast reinforcement all lines, (deferred maintenance arrears estimated 15 million cu. ft.)	—	75·00
E.	Sleepers, deferred maintenance arrears, 1,300,000 ordinary and 3,000 tons switch specials	—	100·00
F.	Rail anchors or anti-creepers, various lines to reduce maintenance costs (1,370,000)	—	18·72
G.	Grand Total, Item 2		947·87*

*Part of the cost of Item A being contributed by US TCA to extent of K12·82 lakhs, reducing the Item 2 total to K935·05 lakhs.

Four items of the Management's program contributed from the United States program for technical cooperation effectively reduce the total estimated cost of Management's program from K2,425·35 lakhs to K2,393·91 lakhs:

	Dollars	*K lakhs*
15 Track Miles 75-lb. rail and fastenings	270,000	12·82
1,178 Rolled-steel Wheels (delivered)	78,000	3·70
42 Sets Carriage Electrical Equipment		
50 Locomotive Headlight Generators		
75 Locomotive Headlights	208,000	9·88
3 Locomotive Boilers		
2 Sets Valve Motion Gear	106,000	5·04
U.S. Aid Total	662,000	31·44

7. ESTIMATED INCOME

a. Traffic Earnings

A detailed study has been made of passenger and goods earnings, both prewar and postwar, and consideration has been given to the effect of increases expected to flow from restoration of law and order and execution of various plans for expanding agricultural and industrial production. Tables XI–23 and XI–24 show conservative estimates of passenger

Table XI – 23

BURMA RAILWAYS

ESTIMATE OF PASSENGER TRAFFIC FOR THREE TARGET YEARS

Based on Rehabilitation of Lines, Restoration of Normal Improved Services, Increased Haul and Increased National Income

	Total Passengers (in thous.)	*Haul per Passenger (miles)*	*Earnings at Present Rates (K lakhs)*	*Average Rate Passenger Mile*		
				Present Rates (pyas)*	*Prewar 6 Years (pyas)*	*Per cent Increase*
1955–56						
Main Line	9,310	30·0	150·00	5·37	2·340	130
Suburban	3,780	15·0	8·06	0·14	0·046	204
Total	13,090	25·7	158·06	4·71	1·970	139
1957–58						
Main Line	10,640	30·0	171·20	5·37	2·340	130
Suburban	4,158	15·0	8·73	0·14	0·046	240
Total	14,798	25·7	179·93	4·71	1·970	139
1959–60						
Main Line	11,970	30·0	193·10	5·37	2·340	130
Suburban	4,410	15·0	9·54	0·14	0·046	204
Total	16,380	25·7	202·64	4·71	1·970	139

Notes: 1 Lakh equals 100,000. 1 Pya equals 1/100 kyat.

If the 19,758,000 passengers carried in 1940–41 at an average rate of pyas 1·97 per passenger-mile, with earnings of K98·79 lakhs, had been carried at the average rate of pyas 4·71, the earnings would have been K235·00 lakhs.

* Including present surcharge of 100%.

traffic and goods traffic for three target years at existing rates. Chart 1 is a graphic comparison of past earnings with the estimated earnings for the three target years, 1956–58–60. The validity of the estimates is supported by a comparison with hypothetical earnings on the past volume of traffic if it had been handled at present rates (see Notes, Tables XI–23 and XI–24, *see pp. 270 and 271*).

Chart 2, average revenues per unit haul, shows how the rates have been increased in an effort to reduce Railways' deficits. These rates should be reducible when traffic volume is restored to or above prewar levels. Attainment of such traffic levels can be hastened by rapidly closing such gaps in the line as the Sittang River and Ava Bridge, but until Railways can operate normally 24 hours a day daily without fear of dacoity (armed robbery by gangs) and sabotage, the increases in traffic volume must be nominal.

b. Working expenses and profit

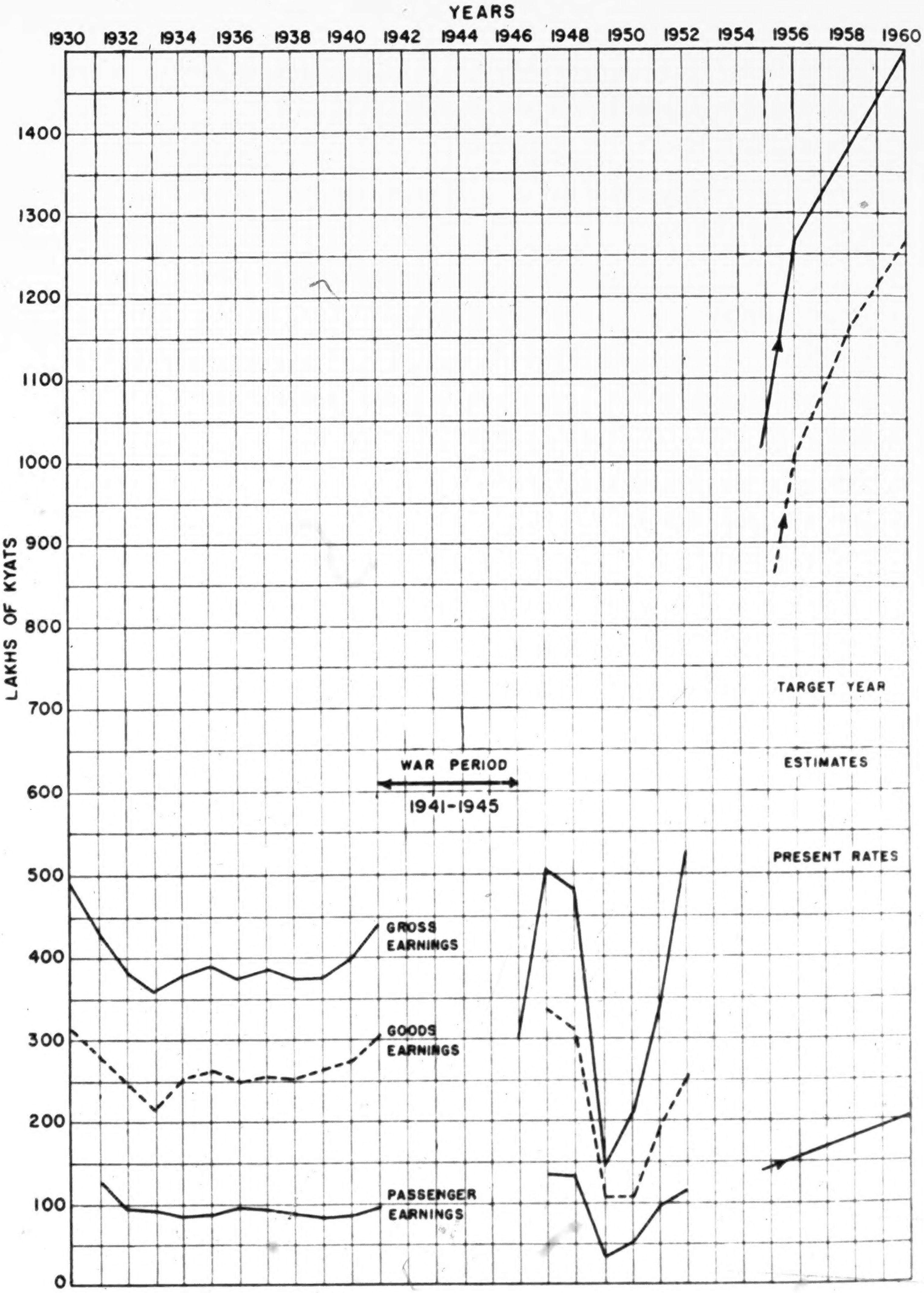
The estimate of direct working expenses has been made on the basis of existing pay scales, cost of living allowances now in effect and present costs of materials and supplies. It also includes revenue charges for the rehabilitation and improvement program for six years. Maintenance and train operation costs have been gradually reduced to reflect the use of new tools, methods and motive power as recommended in paragraphs E–5, 6 and 7 of this chapter.

For depreciation and interest factors, it has been necessary to estimate the growth of capital at charge which will result from the improvement program. If the estimated profits and rate of return shown in Table XI–25 are realized, there will be room to lower rates and encourage traffic (*see p. 271*).

E. REQUIREMENTS FOR FURTHER IMPROVEMENT

1. SCOPE

The foregoing paragraphs have presented the background of Burma Railways and an analysis of the current workings and problems of the system. In this section, after a brief recapitulation of previously mentioned problems and current plans, specific suggestions for further improvements are discussed. Many



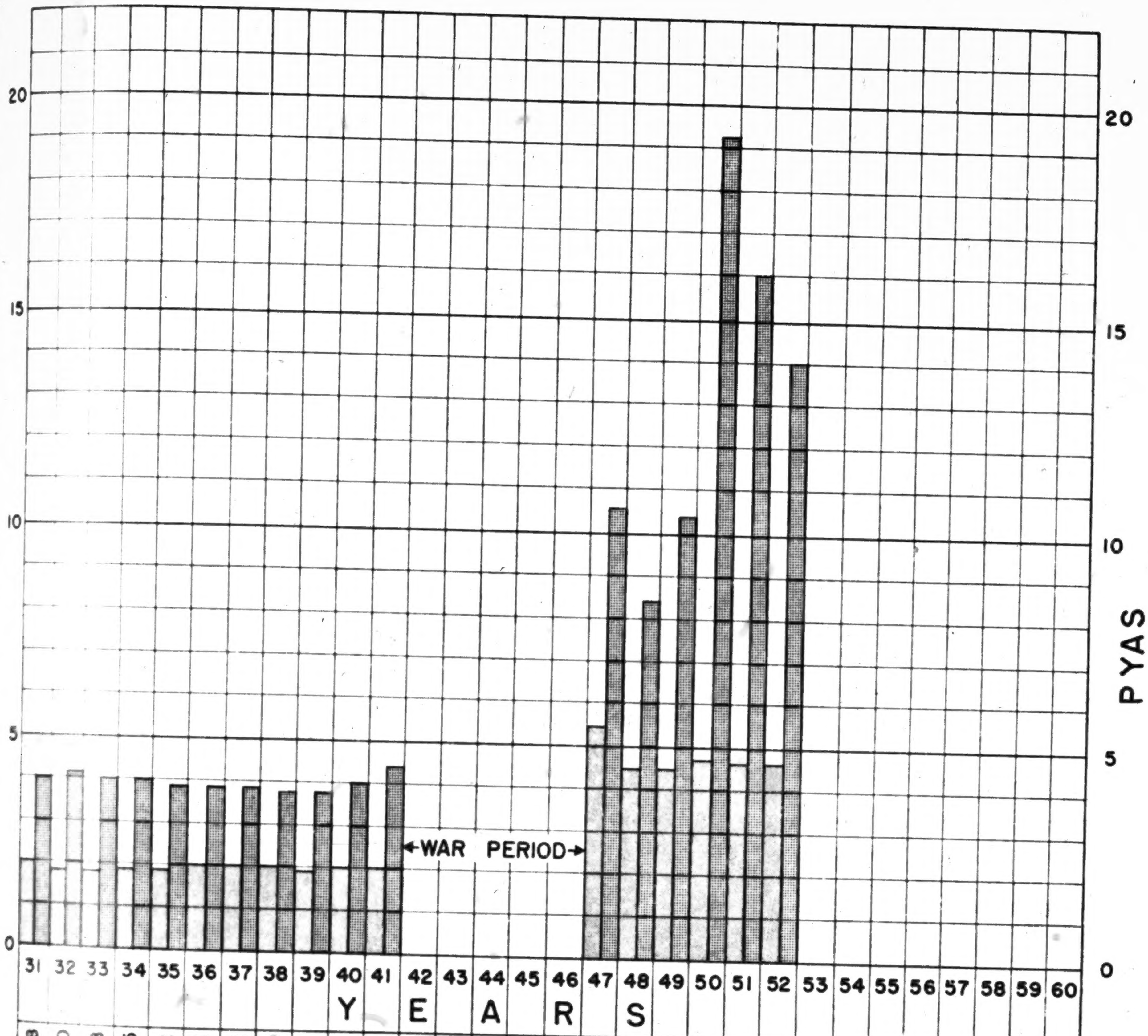
MINISTRY OF NATIONAL PLANNING

RAILWAYS

TRAFFIC EARNINGS

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON

DR BY. E.P.	DATE	CHART	1
CK BY. EWE	MAY. 53	NO.	



YEARS	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
GOODS	3.98	4.20	4.08	4.05	3.92	3.88	3.92	3.80	3.78	4.04	4.37					N.A.	10.57	8.45	10.42	19.25	15.90	14.32								
PASS'GR.	2.03	1.87	1.88	1.90	1.87	1.98	1.97	1.96	1.91	1.97	1.97					N.A.	5.4	4.48	4.38	4.72	4.61	4.56								

▭ AVERAGE REVENUE PER PASSENGER-MILE

▨ AVERAGE GOODS REVENUE PER NET TON-MILE

NOTE: I PYA EQUALS 1/100 th. KYAT.

MINISTRY OF NATIONAL PLANNING

RAILWAYS
AVERAGE REVENUES PER UNIT HAUL

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON.

DR. BY: E.J.P DATE CHART
CK. BY: E.W.E MAY 53. NO. 2

TABLE XI – 24

BURMA RAILWAYS

ESTIMATE OF GOODS TRAFFIC FOR THREE TARGET YEARS

Based on Rehabilitation of Rail Lines and Effect of Increases in Traffic expected to Result from Execution of Plans for Expanded Agricultural and Industrial Production

Period and Commodities	*Tons of Freight (in thous.)*	*Per cent of Traffic*	*Earnings at Present Rates* (K lakhs)*	*Per cent of Earnings*	*Average Rate Per Ton*		
					Present Rates (pyas)*	*Prewar (pyas)*	*Per cent Increase*
1955–56							
Agricultural Products	2,077	53·44	614·60	56·75	29·60	6·17	382
Minerals, excluding Coal	506	13·30	97·95	9·04	19·40	8·90	118
Forest Products	193	4·99	17·86	1·65	9·25	4·50	106
Miscellaneous and Live Stock	337	8·67	174·57	16·11	51·80	25·60	102
Coal, Railway Supplies, Military	773	19·60	178·44	16·45	23·08	11·54	100
Total	3,886	100·00	1,083·42	100·00	27·80	6·80	309
1957–58							
Agricultural Products	2,219	52·63	654·08	56·30	29·95	6·17	385
Minerals, excluding Coal	602	14·28	115·41	9·88	19·25	8·90	116
Forest Products	222	5·26	20·75	1·77	9·25	4·50	106
Miscellaneous and Live Stock	371	8·80	192·17	16·46	51·80	25·60	102
Coal, Railway Supplies, Military	801	19·03	184·91	15·59	23·08	11·59	100
Total	4,215	100·00	1,167·32	100·00	27·65	6·80	307
1959–60							
Agricultural Products	2,428	53·31	711·77	56·30	29·31	6·17	375
Minerals, excluding Coal	668	14·65	132·60	10·41	19·60	8·90	120
Forest Products	247	5·42	22·89	1·80	9·25	4·50	106
Miscellaneous and Live Stock	408	9·02	211·34	16·73	51·80	25·60	102
Coal, Railway Supplies, Military	804	17·60	185·59	14·76	23·08	11·54	100
Total	4,555	100·00	1,264·19	100·00	27·70	6·80	308

Notes: For the 5-year prewar period 1937–41, the average tons carried annually was 3,976,000 tons, with earnings of K271·59 lakhs, or an average of K6.80 per ton. The average lead of 173·2 miles resulting in earnings of K0·0399 per ton-mile.

If the same traffic had been handled at the 1951–52 average rate of K0·1435 per ton-mile, the average 1937–41 annual earnings would have been increased to K976·94 lakhs, or an increase of 260%.

1 Lakh equals 100,000. 1 Pya equals 1/100 kyat.

* Including present surcharge of 100%.

of these suggestions entail adoption of mechanized methods, some of which have heretofore been discounted as inapplicable or unsuited to labor and economic conditions of tropical Asia. These recommendations are, however, made advisedly and after careful study, with the firm conviction that if the methods and equipment proposed are introduced judiciously and gradually they will result in accelerated progress, higher standards of progress and reduced costs.

2. RECAPITULATION OF OPERATING PROBLEMS

The following paragraphs summarize, in the approximate order of urgency, some of the operating requirements already discussed:

(*a*) Restoration of law and order. This is necessary to efficient and expeditious execution of improvements, night running of trains, speed-up of services, and other normal railroad procedures. Without this, time for completion of work now planned cannot be satisfactorily forecast.

(*b*) Closing of gaps in line at Ava Bridge, Sittang River and Daga River to restore traffic.

(*c*) Acquisition of additional goods wagons and passenger carriages, ballast cars, and heavy construction equipment for bridge building and restoration work.

(*d*) Restoration of damaged bridges, destroyed housing, impaired sleepers and ballast.

(*e*) Permanent restoration of branch lines or release of rights of way for highway use.

(*f*) Rail renewals with heavier rail on balance of Rangoon–Mandalay line and later on Rangoon Prome line,

TABLE XI – 25

BURMA RAILWAYS

ESTIMATED EARNINGS, EXPENSES AND INCOME FOR THREE TARGET YEARS

	1955–56 (*K lakhs*)	*1957–58* (*K lakhs*)	*1959–60* (*K lakhs*)
Revenues			
Goods and Live Stock	1,083	1,167	1,264
Passenger	158	180	203
Other Coaching	25	40	45
Total Earnings	1,266	1,387	1,512
Working Expenses			
Structural Works	190	160	150
Locomotive Supply Carriage and Wagons Ferry and Workings Traffic and Trains	612	575	590
General	25	30	30
Miscellaneous	20	20	20
Total Direct Expenses	847	785	790
Depreciation	82	89	93
Total Working Expenses	929	874	883
Railways Net Earnings	337	513	629
Less Interest	122	133	138
Profit	215	380	491
Return			
Estimated Capital at Charge	5,115	5,415	5,615
Rate of Return	4·2%	7·0%	8·7%

Notes: Based on details of Passenger and Goods earnings shown on Tables XI–23 and XI–24.
Depreciation of 1/60th of capital at charge and of previous year.
Interest assumed at 2·5% on same basis
1 Lakh equals 100,000.

releasing 60-lb. rail for branches now laid with 50-lb. or worn 60-lb. rails.

(*g*) General improvement of goods and passenger train services, increased speeds, and recapture of traffic lost to other transport.

(*h*) As a general proposition and commencing at once, a gradual reduction in working expenses, costs and time required for completion of rehabilitation and improvement works.

(*i*) Systematic study and adjustment of the rate structure.

3. CURRENT REHABILITATION PROGRAM

The Management program is generally well thought out and covers the physical work and acquisitions necessary to bring the railroad plant and rolling stock back to their normal position of prestige and efficiency among the transport agencies in Burma. After further critical study and the preparation of detailed estimates for various segments of the work, the program should be carefully scheduled over a practical period of not less than six years. Time allotments for work acquisitions should be guided by the considered judgement of Management after a review of all factors. Each year thereafter, the scheduling for the balance of the program should be adjusted to what has been accomplished, and estimated costs should be reviewed and reallocated in the light of experience and current conditions. For purposes of this Report, the program will be considered as requiring six years for its execution, with expenditures allotted at arbitrarily estimated rates.

4. SPEED OF PROGRAM EXECUTION

Under the conditions existing in Burma, only the most intensive detailed planning and aggressive prosecution of the work can result in attainment of the ambitious goals set for achievement in six years. If the railroad is to be restored in such a period, Railways must be authorized to place long-range orders for rails, bridge steel, rolling stock and other important items well in advance to insure that suppliers can and will make deliveries to fit the progress schedule. A wait of five years, as in the case of Ava Bridge steel, for example, should not be tolerated. Orders for such important works should be placed on a firm delivery or penalty basis, even if the cost be slightly more than that of the lowest bidder. Time saved will be translated into substantial earnings and lowered working expenses which will more than support the increased costs.

A complete, efficient and well-functioning railroad operation is essential to the success of government plans for increased agricultural production and industrial development, and for the consequent improvement of economic conditions in all Burma. If Railways is to accomplish quick results, it will need aid in short-circuiting administrative obstructions, indecision and delays of the kind that retarded designs for the new Sittang River Bridge for nearly six years. Such delays deprive Railways of earnings on substantial traffic which cannot be handled until the gaps are closed.

The Ministry of Transport and Communications should assist Railways in obtaining decisions of higher authorities, in expediting cooperation required from other government agencies, and in reconciling its needs and requirements with those of other agencies by prompt and aggressive action.

Railways Management also should press vigorously its case for implementation of the program, but it should insure that execution of work authorized does not lag. Both to improve Railways' earnings and to release labor for new enterprise, management should aggressively adopt applicable new methods, machines and practices found successful elsewhere, and must divorce itself from traditional wasteful uses of cheap human labor.

5. MAINTENANCE OF WAY

a. Rail Renewals

Renewals, with new 75-lb. and relayer 60-lb. rail, are programmed for nearly 600 track miles. The plan calls for an average laying of 30 miles of 60-lb. and 70 miles of 75-lb. or a total of 100 miles annually for six years. However, the work should be done more rapidly and in not more than four years. To eliminate the delays heretofore experienced, steel can be secured in world markets other than the customary India and United Kingdom sources.

Rail renewals should be made by a small, well integrated, and specially trained crew housed in mobile quarters provided with reasonable amenities. Equipment should include a complement of modern hand tools, a modern power crane for handling rails and portable power tools such as a power adz, sleeper borer, spike puller, spike driver, bolt tightener, hack saw and rail grinder. Adequate track motor cars and trailers should be provided for rapid gang transport from set-out point to the job so that time lost in walking can be eliminated. For renewing sleepers, follow-up lining, surfacing and dressing up, a gang should be equipped with a mobile power plant and with air or electric ballast tampers. Such gangs would require competent trained supervisors and assistants, and once organized should be kept regularly employed until the job is done. The equipment costs of about K4 lakhs would be saved many times in lowered costs.

b. Ballast Work

Ballast work under the current program will be performed largely as reinforcement work, and much ballast will be placed by regular local gangs. However, some districts will require the services of a specially trained ballast gang which should follow and be equipped with the same sort of mobile housing, tools and transport as the rail gang. The cost for such equipment need not exceed K2 lakhs. Ballast is now costing Railways about K40 per 100 cubic feet or five times the prewar quarry price, with labor cost for coolies increased in about the same proportion. Prewar ballast requirements were about 5½ million cubic feet annually, obtained principally from private contractors. The Chief Engineer estimates the present backlog as 15 million cubic feet.

It is strongly recommended that Railways carefully investigate the results to be obtained by establishing a modern crushing plant of its own at a cost of about K5 lakhs, or that it enter into a long-term contract with the Department of Roads or a private enterprise under terms which would support production of ballast with modern high-capacity machinery. So-called "portable" rock-crusher plants are available with capacities conservatively estimated at 500 tons or 10,000 cubic feet daily. If set up at a suitable quarry face, one such plant, working two shifts for 300 days, could supply Railways with its annual ballast needs. Two plants would supply rock for all needs. These plants could be moved from year to year to the quarry nearest the major requirements to reduce costly haul, and surplus rock could be sold. With a trained ballast gang and reliable source of supply, ballast work could be effectively carried on almost continuously.

Existing ballast cars are constructed to dump only outside the rails, and all ballast needed between rails is shoveled or hoed in by hand, a costly practice. A quota of about 75 modern, 40-ton ballast cars with controlled dumping either center, side, center and one side, or center and both sides, could be obtained at a cost of about K30 lakhs. When not in use as ballast cars, they could be used commercially for hauling coal and similar materials.

c. Track Maintenance Gangs

These now average about 2½ men per mile on sections of about four miles. Men walk to work carrying their meager allotment of tools. Much dressing up of ballast is done with bare hands. Railways should at once commence a program of providing gangs with motor cars, trailer cars, adequate hand tools and equipment, and should gradually eliminate two gangs out of three. Many men can be transferred to rehabilitation work for several years. Considering conditions in Burma, gangs of 12 men with proper equipment and transportation should very adequately maintain 12 miles of line, except on ghat sections where extreme grades and curvature are encountered. Surplus personnel can be absorbed in rehabilitation and extension of the system.

On the basis of equipping 1,700 miles of line, about 150 eight-man motor cars and 150 trailers would be required, costing K11 lakhs. A garage tool shed and additional hand tools for each gang would require another K6 lakhs. The eventual release of coolie forces to other work would be about 2,400 men, saving K22 lakhs annually, or in one year an amount equal to 1⅓ times the first cost of the new equipment. Savings would also accrue from the release of living quarters, medical services, supervisors and accounting time. About 40 small motor inspection cars suitable for two to four men would cost about K2 lakhs, would save wages of peons now used to push engineers and supervisors slowly over the line on hand push trolleys, and would enable such officers to handle more territory.

d. Equipment for Heavy Construction and Maintenance Work

This is insufficient in quantity and character for rapid and efficient work on some of the large jobs such as, for example, the Sittang Bridge piers which must be sunk through 100 feet of river-bottom silt. It is recommended that a careful selection of mechanized construction equipment be acquired, and to include such items as the following:

Caterpillar tread shovel and two long-boom cranes of good capacity.
Supplemental orange-peel and clam-shell buckets.
One crane with heavy magnet equipment.
Drag-line excavator attachments.
Steam pile-drive unit.
Air compressors and reservoirs.
Pumps, self-powered units of various sizes, large and small.
Small electric plants for power and lighting.

Some of this equipment can be obtained in combination units. Such tools will reduce costs and save sorely needed time. The total cost of such long-lived plant need not exceed K30 lakhs.

e. Weed and Heavy Brush Control

Weed and heavy brush control in Burma is presently all hand work. Results which can be achieved by brush-killing chemicals and chemical weed control should be thoroughly investigated.

f. Salvage

Wreckage and scrap from the war and insurgent operations litter the railroad property, particularly on the Rangoon–Myitkyina line. Hundreds of bomb- and gun-shattered and wrecked wagons and carriages lie on every hand. Large collections of wrecked locomotives are gathered at Insein, Yamethin, Yawataung and other points, and many more are on line. Railways have in this wreckage hundreds of usable wheels, axles, couplers, draft springs, brake rigging and other materials, in addition to a substantial tonnage of scrap rail. It is recommended that a well organized special gang be equipped with a heavy crane, small tractor, wire ropes, cutting torches, and other suitable gear for retrieving and concentrating these materials at strategic points for inventory and classification. This will have to be done some time, and now is a good time to start. Existing tools and equipment could be diverted for this work.

It is further recommended that the Railway Board seek Government sanction to process all scrap suitable for shipment to rail mills as a partial substitute for cash on rail orders. Open-hearth steel mills are always in need of scrap. The customer with a substantial amount of it is able to trade advantageously as to price and delivery. The waste inherent in continuing to use full cash to buy new rails while neglecting to use this presently wholly unproductive but valuable scrap will be evident.

6. RAIL AND MECHANICAL EQUIPMENT

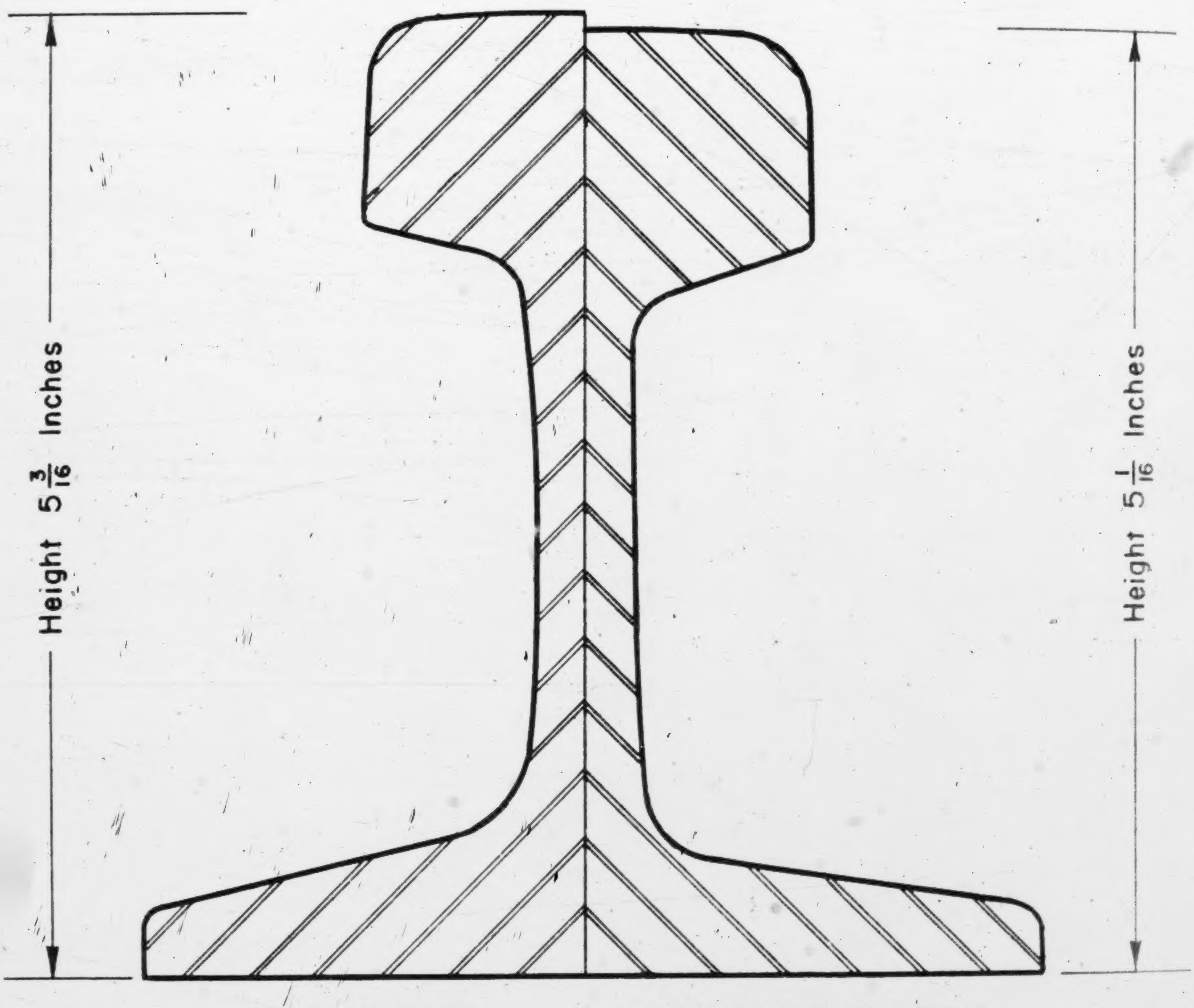
(*a*) The design of the 75-lb. rail section now standard on Burma Railways no longer represents what is considered to be the most efficient and effective use of the metal. In view of the large tonnage of this weight to be laid on the main line where higher speeds than ever before in Burma eventually will be commonplace, Railways should adopt a new cross-section with better girder strength and deeper fishing space for joint bars. The general proportions of a recent rail section are compared with the present standards of Railways on Plate 5. Railways should start study at once so that a better rail section can be obtained on current and future rail orders.

(*b*) Better track for high speeds will result if staggered rail joints are used. The effectiveness of this practice has been demonstrated by its use in United States, Canada and Mexico for more than 60 years on track bearing extremely heavy loads at very high speeds. As the new 75-lb. rail is laid, the joints should be respaced to the staggered standard now already followed by Railways on curves.

(*c*) When sleepers are pre-bored before creosoting at the Myohaung plant, eight holes should be bored. If this is done, as it should be, by two four-spindle drills simultaneously, no extra production cost will be involved. Penetration of treatment under the rail seat will be greatly improved and sleepers will be ready, without field boring, for double spiking on outside of curves where necessary.

(*d*) Speeds are bound to increase on the main line, and curves over 3° should be fitted with four-hole bearing plates so that the dogspikes, both inside and outside, will combine to resist thrust against the outer rail. The number of plates required to thus outfit the main line will be nominal.

(*e*) On the ghat sections and where curvature is sharp, gradual installation of fixed-position track oilers will be found profitable in saving rail wear and wheel-flange wear. These devices, actuated by the passing wheels, automatically feed a small amount of heavy oil onto the wheel flanges. This oil is carried


Height $5\frac{3}{16}$ Inches
Height $5\frac{1}{16}$ Inches

RECOMMENDED
SECTION

AREAS	SQ.INCH	PERCENT
HEAD	2·81	38·2
WEB	1·66	22·6
BASE	2·88	39·2
TOTAL	7·35	100·0

STANDARD SECTION
BURMA RAILWAYS

AREAS	SQ.INCH	PERCENT
HEAD	3·21	43·7
WEB	1·56	21·2
BASE	2·58	35·1
TOTAL	7·35	100·0

MINISTRY OF NATIONAL PLANNING

RAILWAYS
COMPARISON OF SECTIONS
75 Lb. RAIL

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK. RANGOON.

DR. BY. E.J.P. DATE MAY 53. PLATE NO. 5
CK. BY. EWR.

around the curve without affecting traction on top of the rail. Rail life on curves is greatly extended in this way. One oiler often serves several curves.

(*f*) A gradual program of equipping additional goods vehicles with vacuum brakes should be initiated. Efficient operation will eventually require higher speeds on goods and mixed trains. Better control and shorter stoppings will be imperative from a safety standpoint. Higher speeds will reduce investment in wagons by increasing the utilization factor.

(*g*) Non-synchronizing snubber springs should be applied to bogies on American-type "box" cars on line to eliminate the "bounce" now detrimental to loadings and track. Data on these devices has been furnished Railways.

(*h*) Sandblasting should be employed at Myitnge shops for removal of rust on underframes and structures of the large number of wagons undergoing rehabilitation. This work is now being done ineffectually by slow and costly handwork. Sandblasting will do a much better job faster and cheaper. Data on suitable equipment has been furnished Railways.

(*i*) In general, new wagons should be of heavier capacities than standards now used. The added cost is nominal in comparison with the added strength, improved revenues per wagon, and increased operating efficiency.

7. DIESEL-ELECTRIC LOCOMOTIVE OPERATION

Utilization efficiency of locomotives on Railways is understandably low under present conditions. Out of 307 steam locomotives owned, 187 or 68% of the total tractive effort is comprised of locomotives built since 1946 as shown in Table XI–6. From a traffic-movement standpoint alone, it is unlikely that Railways will require any additional motive power for several years.

However, from a standpoint of economy through reduction of working expenses, after insurrection troubles have subsided, and when traffic density has improved to a point where some diesel-electrics can be kept in active heavy-duty service for 80% or more of the potential hours, a gradual change to diesel-electric power is recommended. When such conditions develop for any segment of train-service, a railroad can no longer afford to operate steam locomotives in that segment of service even though dieselization may involve laying some steam power aside in idleness, or as scrap, regardless of its age.

While diesel-electrics are high in initial cost, two will serve in place of three steam locomotives of approximately the same tractive power. This is because of the high degree of mechanical availability which approaches 90%. How then should Railways prepare to reap the substantial benefits of partial dieselization when density of traffic volume shall make the investment profitable?

(a) First, it is recommended that Railways promptly secure six diesel-electric combination road or shunting locomotives for service in the Rangoon area as shunting engines and for use during rush hours on Rangoon suburban trains. A representative American-built locomotive suitable for such use would be the following:

400 h.p.—43 metric ton—4 axles—meter gauge.
Combination Road and Shunting Locomotive.
Tractive Effort—Initial —29,700 lbs.
,, ,, —Continuous Rating—12,100 lbs.
Speed up to 50 m.p.h.
All with suitable brakes, couplers, etc.
Approximate cost, Rangoon—K3,92,000.
International General Electric Company, Manufacturer.
Schenectady 5, New York, U.S.A.
Locomotive Specification No. 4359-E.

The locomotive described is powered by two 200-h.p. Caterpillar diesel engines, each directly connected to an electric generator. All four axles are individually motor-driven through enclosed gear trains. This specific recommendation is made for the following reasons:

(1) The locomotive is a unit of highest quality and has been long proven by numbers in use, both in standard and meter gauge types.

(2) The Caterpillar diesel engines are known and serviced all over the world. Parts are readily obtainable.

(3) The locomotive can be used for shunting, passenger or road-freight service anywhere.

(4) If provided with multiple-unit control circuits, locomotives can be used in tandem with one set of controls, thus permitting use as a single locomotive.

(5) The axle load of 12½ metric tons is within Railways bridge limits for non-reciprocating locomotives.

This initial installation is urgently recommended in the Rangoon areas because it would provide improved service, would afford much needed information, and would create a training ground for diesel and electrical maintenance personnel at headquarters under close supervision. With the technical and working experience thus gained, Railways would be prepared for gradual extension of diesel-electric operations on main-line districts when the economies become favorable.

(b) Second, if traffic in Burma improves materially in the next few years, as planned for and expected, the time for use of diesel-electric locomotives for the principal volume of main-line traffic may not be far distant. When that time comes, some of the steam power can be sold, stored or scrapped. The ideal operation would be to keep the diesels fully busy on the constant "backbone" of traffic and to handle seasonal peaks, short runs and low-density branch lines with existing steam power. The relatively higher cost of diesel-electric locomotives demands that the investment be kept almost constantly productive.

Although two 400-h.p. locomotives can be used in road service as an 800-h.p. locomotive, main-line operations would be better handled by more powerful unit types of about 1,000 h.p. to 1,500 h.p. After detailed studies of train tonnages and speeds, a combination type suitable for freight or passenger work should be selected, with an initial tractive effort between 30,000 and 45,000 lbs. and suitable wheel arrangement for Railways' axle-load limits.

(c) Third, it is estimated that traffic requirements will be such by 1958 that about 25 road service passenger and freight diesels should be in use and about nine additional combination road-shunters, with the main line almost entirely dieselized and branch lines running with coal or oil-burning steam power. The investment for such additional equipment would be approximately:

	Lakhs
9 Additional Road-shunters at K3·90 lakhs	K35·1
25 Road Freight and Passengers at K8·3 lakhs	K207·5
Total	K242·6

(d) Overall economies to be expected from use of the foregoing diesel-electric locomotives are several. Their exact determination would require an analysis of specific conditions, presently not practical. The major economies would result from lower fuel and repair costs and better locomotive utilization. On the basis of 165 lbs. of coal and 1·5 imperial gallons of diesel oil per 1,000 gross ton miles, the coal cost would be K7.06 versus a diesel-oil cost of K1.80 with coal costing K96 per ton at dock and diesel oil K1.20 per imperial gallon. If the 1940–41 gross ton miles had been handled only one third by diesel-electric locomotives, the fuel purchase costs would have been reduced by K49 lakhs on the basis of today's prices. Equivalent mileage locomotive repairs would have been reduced by at least 50%.

(e) A final word of caution is that locomotives of different manufacture should be fully investigated as to first costs, performance, maintenance costs, reliability and other factors. The manufacturer, once selected, should be retained for future acquisitions unless some extraordinary defects develop. If four or five different types are used, the investment in different sets of spare parts and tools becomes a burden. The road-service type finally selected can and should be suitable for operation in either goods or passenger train service so that maximum utilization can be obtained.

8. COAL HANDLING

Coal handling on Railways should be mechanized to save both coal and handling expense. At present, coal on the dock is loaded in covered wagons, unloaded and stock-piled at destination, and finally loaded on locomotives by coolies with head-baskets. Waste from breakage and dust loss inevitably occurs at each handling. Proposed port improvements at dockside will reduce the cost of unloading from barge or ship. Railways will eventually substitute diesel-electric locomotives for much of its main-line traffic, but will continue to burn coal on branches. Consequently, mechanical coal storage and loading plants of moderate capacity should be installed at branch-line junction points. Such station would receive coal from center-dump hopper wagons and elevate it to storage and service "tanks" above. The elevated coal trestle and side bunkers should be considered obsolete because of their high first cost and high maintenance cost.

9. CENTRALIZED TRAFFIC CONTROL SIGNALS

A special project report has been prepared setting forth advantages of train control by means of outlying signal indications operated from a central point. The project report emphasizes the fallacy of replacing any part of the second main track, formerly existing from Togyaunggale 170 miles north of Kyungon, which was destroyed or carried away during the war.

The project report also shows that Centralized Traffic Control (CTC), should receive careful consideration on its own merits, without respect to the second track argument, as a method more speedy, economical and safe than methods heretofore used: CTC will endow a single track with train capacity

TABLE XI–26

CENTRALIZED TRAFFIC CONTROL

	Kyats
Investment	
170 miles additional main track	3,05,00,000
CTC signals, switch machines, etc.	82,00,000
First Cost Savings in favor of CTC	2,23,00,000
Annual Costs and Amortization	
170 miles additional main track	23,08,455
CTC signals same distance	7,00,990
Savings in favor of CTC	16,07,465
Other operational savings due to CTC on single track	5,00,000
Total Annual Savings in favor of CTC	21,07,465

equal to 75% of that of double track and will effect large savings in working expenses. It may be installed in sections over a period of years to suit conditions and finances. Costs relating to the 170 miles analyzed in the project report are shown in Table XI–26.

If annual operational savings at K5 lakhs be capitalized at 5%, the investment warranted would be K100 lakhs compared with a first cost for CTC of K82 lakhs. Thorough study of the related project report should be made before proceeding too far with acquisition of the expensive hand-operated electric-type station signals now planned for the main-line replacements.

10. ADMINISTRATION

a. Working Expenses

Costs of railroad working expenses have increased greatly since the war, both for personnel and materials, but since costs of most materials are beyond control of Railways, it must look for economies largely in reduction and more efficient use of staff by employment of improved methods and labor-saving devices. This will involve much planning and may require a determination to break sharply with traditional practices.

Staff on Railways, although proportionately smaller than on some other Asian lines, is demonstrably much larger than required to successfully and profitably operate the railroad under normal conditions if mechanized practices are employed. The figures below provide a comparison of the manpower used at present in Burma with the manpower utilized by a typical US railroad operating in similar terrain, but with traffic aggregating about five times the prewar traffic in Burma:

Total Employees	*US Ry.*	*Burma Railways*
Employees per mile of road	4·3	10·7
Employees per mile all tracks	2·6	8·6

Generally speaking, Railways has also a very high percentage of supervisory staff with very small jurisdictions, considering the density of its traffic. Savings should be effected gradually as retirements occur by consolidating some districts and granting increased compensation for officers taking on increased responsibilities.

b. General Offices

General offices at Rangoon are inadequate for forces employed. In many cases clerks and others are working in quarters with inadequate light. Files and records are stored on open shelves or on floors where they become deplorably dusty and dog-eared. An increase in working space should be provided. All interiors should be painted with light-coloured lusterless paint of pleasing tint and provided with adequate non-glare shadowless lighting. A good quota of modern electric adding machines and electric calculators should be provided in the general office (and important outlying offices) to save time in compilation of accounts and statistics. Study should be made with the intent of adopting an enclosed vertical filing system suited to Burma conditions. Total cost of such changes need not exceed K4 lakhs and would result in greatly improved labor conditions and better efficiency.

c. Repair Costs for Sabotage

Repair costs for sabotage and expenses of armed escorts and armored trains should be credited to Railways by Government because such costs are not true working expenses of a normal railroad operation but are part of the general security costs of Government.

d. Accounting Records

From a reading of Table XI–20 and paragraph D–4 of this chapter, it would appear that decisive action should be taken to clear up uncertainties existing as to the earnings, expenses and income of Railways during the postwar period. Evidently books for past years are not yet closed, although prewar annual reports were completed and consistent from year to year on all counts.

It is recommended that a prewar model annual report be issued for 1952–53 not later than three months after the close of the fiscal year on September 30, complete with all traffic, operational and financing information. Unaudited items in any account should be estimated and included in Operating and Balance Sheet accounts and later adjusted and included in the same accounts in the following year's report, with appropriate explanation if the entry causes undue distortion. Delayed items and retroactive payments or adjustments should be handled in the current year, and, if desirable, pro-rated over several months to avoid distortion in any one month.

e. Accounting Organization

Accounting is now in charge of the Controller of Railways Accounts who has a dual responsibility to the General Manager of Railways and to the Auditor-General of the Union of Burma. The Statistical Officer reports to the General Manager and is responsible for preparation of the annual reports but has to obtain all money data from the Controller's office. Consequently, divided responsibility and confusion exist with respect to statistics and annual reports.

Interests of Railways and Government would best be served by having the Controller appointed by and responsible to the General Manager and responsible for the integration and correctness of all financial and statistical reports and compilations. Appropriate check by Government could be arranged for in a manner desired by the Auditor-General.

f. Ticketless Travel

This evil is much worse than detection figures indicate, as shown by recent surprise checks. It can be entirely suppressed by providing means for passing from one carriage to the next while the train is in motion, and placing ticket collectors on the train who pass from end to end of the train (or certain group of carriages assigned) after each stop. All of North and South America, Japan, China, North and South Africa, and all modern trains in Europe, provide end to end communications on trains in motion, and have no ticketless problem of any consequence. As soon as possible, passenger vehicles should be modified to provide through passage.

g. Interest

Under the government fiscal system, interest on Railways book record "Capital at Charge" cannot be reduced except by reduction of plant and consequent reduction of book record costs of road, equipment and rolling stock. Every addition to plant increases the capital at charge, and interest increases proportionately. Stated in another way, every addition is treated as if acquired 100% with borrowed money, with no provision for reduction of debt or interest.

A revision of this system is recommended so that Railways can make the normal run of substantial plant additions from earnings, when available, without increase of interest, leaving only the costs of important extensions or major additions to plant on the borrowed-money basis. This might be accomplished by issue of Railways bonds, guaranteed by Government and with sinking fund provisions for retirement at maturity.

h. Specifications and Standards

Railways should cease using specifications and standards entitled "Government of India" or "Indian Railways," and should adopt any available specification found suitable for Railways needs. Such specifications and drawings should be labelled "Burma Railways," with a note reference to origin, if desirable for manufacturers.

i. Technical Periodicals

Information on railroads everywhere and their practices is vital to progress. It is strongly advised that Railways subscribe to the following monthly American railroad publications, in addition to British and other publications now received:

	Two-Year Foreign Subscription
Railway Mechanical and Electrical Engineer	$12.00
Railway Engineering Maintenance	$12.00
Railway Signalling and Communications	$12.00
	$36.00

(Simons Boardman Publishing Company, New York 7, New York, U.S.A.)

These magazines, both text and advertisements, will be of great service to officers and technical personnel in their studies of railway practices.

j. Liaison Visits

Visits abroad to various countries will be more beneficial if made by senior staff officers who are in a position to take direct action on practices noted and considered desirable for adoption by Railways, whereas younger staff officers will sometimes have difficulty in convincing their superiors of the virtues of some method observed and considered by them as desirable.

k. The Association of American Railroads

The Association of American Railroads, Transportation Building, Washington, D.C., is a cooperative organization maintained for the purpose of standardizing materials, certain methods and practices, and for group action on various railroad matters. It also aids and embraces the various major railroad engineering associations, conducts railroad laboratory research and prepares analyses of problems important to the industry. Inquiries as to technical practices or where American products can be obtained, if addressed by Burma Railways to the Association, will always receive courteous attention. Railways is urged to avail itself freely of the opportunities offered for cooperation and assistance.

11. SUMMARY OF COSTS

Due to many obvious uncertainties relating to Railways operations under conditions now existing, any year-by-year timing for expenditure proposed must be approximate. Table XI–27 shows a desirable allocation over six years which, if followed, would result in a speed-up of program execution and early realization of the economies attainable by more efficient operation and use of improved methods of works construction.

F. CONCLUSION

In common with the accomplishments of railway men in other war-torn countries, Burma railwaymen, from staff officers to coolies, have behind them a fine record of repairing war damage and restoring service. Considering the conditions of insurgency existing continuously since early 1949, and the remoteness

TABLE XI – 27

SUMMARY OF REHABILITATION AND OTHER IMPROVEMENTS

Excluding Costs Donated by US TCA

Work or Acquisition	*1953 (K lakhs)*	*1954 (K lakhs)*	*1955 (K lakhs)*	*1956 (K lakhs)*	*1957 (K lakhs)*	*1958 (K lakhs)*	*6 Years Total*
Management Program (Table XI–22)							
Civil Engineering Works	262·00	427·00	434·00	375·00	158·94	104·75	1,761·69*
Mechanical and Rolling Stock	46·96	192·00	170·00	120·00	90·00	13·26	632·22*
Total Program*	308·96	619·00	604·00	495·00	248·94	118·01	2,393·91*
Other Recommendations							
Equipment for Rail Gang	—	4·00	—	—	—	—	4·00
Equipment for Ballast Gang	—	2·00	—	—	—	—	2·00
Rock-crusher Plant	—	5·00	—	—	—	—	5·00
75 Ballast Cars	—	—	30·00	—	—	—	30·00
Heavy Construction Equipment	—	30·00	—	—	—	—	30·00
Track Maintenance Motors and Tools	—	9·00	8·00	—	—	—	17·00
Motor Inspection Cars	—	2·00	—	—	—	—	2·00
General Office Changes	—	2·00	2·00	—	—	—	4·00
Scrap Reclamation Program	—	—	—	—	—	—	—
9 Additional Diesel-electric Shunters	—	—	20·00	15·10	—	—	35·10
25 Diesel-electric Road Locomotives	—	—	50·00	75·00	82·50	—	207·50
Total Other Items—KTA	—	54·00	110·00	90·10	82·50	—	336·60
Total Program and KTA Items	308·96	673·00	714·00	585·10	331·44	118·01	2,730·51*

*Items reduced from Management's program by K31·44 lakhs, the amount of US TCA contributions.

from sources of equipment and materials supply, the results have been outstanding.

Opportunity now exists for Burma Railways to better its good prewar service record and to move forward to become the most progressive railway in East Asia. With adoption of new methods and a continuance of the fine courage, skill and tenacity of purpose heretofore shown by the entire staff in the face of extraordinary difficulties, consummation of such a result seems assured. The various measures that are proposed or discussed in the foregoing pages and that are recommended here as a means of materially facilitating and expediting this splendid objective are condensed and summarized in the following paragraphs.

1. The following modifications and improvements in present practices, equipment, and administration are recommended:

(*a*) That continuing improvement through increased mechanization, introduction of power handling, and procurement of high-production equipment be adopted as a positive policy.

(*b*) That the current improvement program be scheduled over a six-year period, reviewed and revised annually to accommodate changes in the situation.

(*c*) That immediate efforts be made to expedite the general rehabilitation measures, closing of gaps and improvements in services and efficiency as summarized in paragraph E–2 above.

(*d*) That new equipment and methods of operation for maintenance of way and improved rail and mechanical features be adopted and introduced gradually as experience is gained and as personnel can be absorbed on new work or curtailed through normal attrition (paragraphs E–5, E–6).

(*e*) That the use of diesel locomotives be introduced with a pilot purchase and familiarization program beginning with combination road and shunting engines for the Rangoon and suburban areas (paragraph E–7).

(*f*) That coal handling be mechanized and simplified (paragraph E–8).

(*g*) That centralized traffic control be instituted in stages beginning with 170 miles of main track (paragraph E–9).

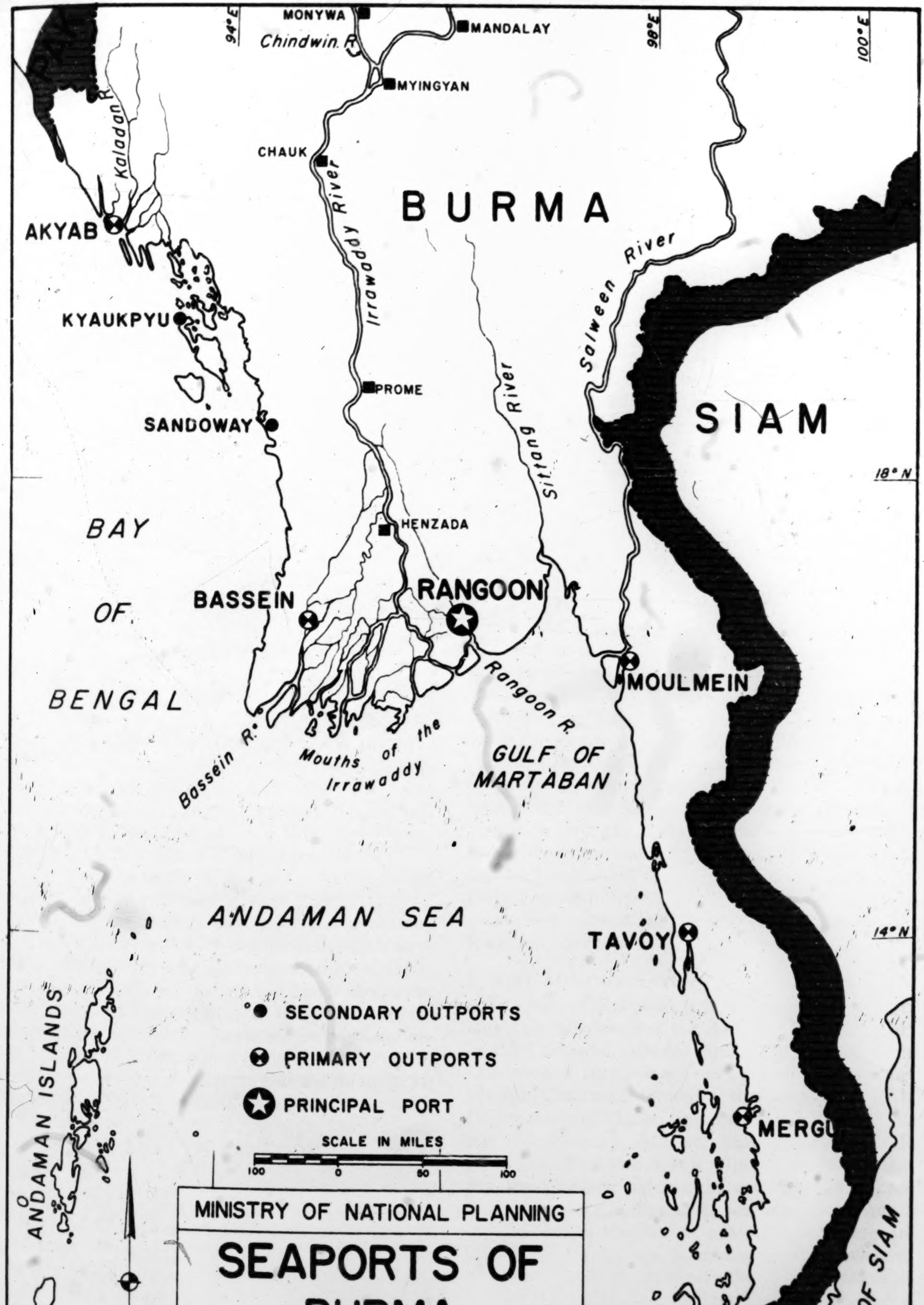
(*h*) That administrative practices be studied and revised to reduce labor costs, correct accounting weaknesses, provide adequate office space and increase the availability of technical information (paragraph E–10).

2. To insure the expeditious and coordinated implementation of this or any program of improvement, it is further and urgently recommended:

(*a*) That the Ministry of Transport and Communications aggressively support Railways by granting prompt decisions, by expediting the services of other departments affecting Railways, and by exacting prompt coordination of interdepartmental actions.

(*b*) That Railways be authorized to undertake long-range purchasing under contracts fixing firm delivery dates.

(*c*) That Railways establish in its own organization a highly placed center of responsibility for rehabilitation and development headed by a broadly trained and widely experienced railway executive, serving in a capacity such as special deputy manager or special assistant to the Manager or as Consultant.



MONYWA
MANDALAY
Chindwin R.
94°E
98°E
100°E
MYINGYAN
Kaladan R.
CHAUK
Irrawaddy River
BURMA
AKYAB
Salween River
KYAUKPYU
PROME
Sittang River
SIAM
SANDOWAY
18° N
BAY
OF
BENGAL
HENZADA
BASSEIN
RANGOON
MOULMEIN
Rangoon R.
Bassein R.
Mouths of the Irrawaddy
GULF OF MARTABAN
ANDAMAN SEA
TAVOY
14° N
ANDAMAN ISLANDS
● SECONDARY OUTPORTS
⊗ PRIMARY OUTPORTS
✪ PRINCIPAL PORT
SCALE IN MILES
100
0
50
100
MERGU
GULF OF SIAM
VICTORIA POINT
10° N
100° E

MINISTRY OF NATIONAL PLANNING

SEAPORTS OF BURMA

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY H.R.N.
CK. BY
DATE MAY 53
PLATE NO. 1

CHAPTER XII

SEAPORTS OF BURMA

A. INTRODUCTION

Although rail and highway facilities leading to bordering countries can be extended and better exploited, the physical difficulties of such routes will always preclude their competing economically with seaborne transport for bulk freight movement. Burma must therefore rely largely upon seaborne commerce to maintain its position in world affairs and trade. The principal foreign income of the country is derived from the export and sale of rice and rice products. Even after a high degree of self-sufficiency has been attained through mechanization and industrialization, the well-being of Burma's citizens will continue to depend to a large extent on the exchange of Burma's products for foreign general merchandise. Without seaports to accommodate the cargo fleets of seagoing, coastwise and riverine commerce, this essential foreign trade would collapse. Without efficient cargo-handling facilities in these seaports an expanded trade cannot be sustained.

The main seaport of Burma is the Port of Rangoon. It accounts for about 85% of the foreign trade and 44% of the coastal commerce, and is the principal terminus for the riverine commerce of the waterways of the great Irrawaddy River and delta systems, as well as for the railways, highways and airlines. It is the only port capable of receiving and effectively distributing goods to the larger part of the country.

The principal outports of Burma are Akyab, which serves the Arakan region of western Burma; Bassein, which serves the western section of the Irrawaddy delta; and Moulmein, Tavoy and Mergui, which serve the Tenasserim section of southeastern Burma. Other minor ports include Kyaukpyu and Sandoway in the Arakan area and Victoria Point at the extreme southeastern tip of the country. These minor ports are engaged primarily in coastal commerce. The Port of Rangoon, the principal outports and the minor ports are shown on Plate 1 entitled, "Seaports of Burma."

B. PORT OF RANGOON

1. GENERAL

The city and the port of Rangoon are situated on the left bank of the Rangoon River about 21 nautical miles from the Gulf of Martaban, Andaman Sea. Rangoon is the capital and principal industrial and trade center of Burma. The public wharves and jetties (floating pontoon landings) all are along the left bank of the river, and extend for about seven miles upstream from the beginning of the harbor proper at Monkey Point. Private and government establishments extend along the south or right bank of the Rangoon River and along both banks of Pazundaung Creek. There are three main wharf sections where ships can be unloaded directly, a total of ten berths varying in length from 450 to 500 ft. and with channel depths alongside up to about 30 ft. Seven of these berths comprise the Sule Pagoda Wharves Nos. 1 to 7, two are known as the Brooking Street Wharves Nos. 1 and 2, and one is called the Ahlone Wharf. Sule Pagoda Wharf No. 5 is out of operation because of extensive war damage, and Nos. 6 and 7 are used for lighterage operations because of inadequate foundation conditions. Public jetties or floating pontoons are provided for public use at the Lanmadaw and Botataung foreshores. These jetties are for the use of coastal vessels and for government and private riverine craft; three jetties can accommodate seagoing vessels. There are over 20 free-swinging and fixed moorings in the Rangoon River for seagoing vessels where loading and unloading may be accomplished through lighterage. Anchorage areas are provided for country craft and cargo boats, and moorings are provided for petroleum vessels in both the Rangoon and Pegu Rivers. The Burma Railways and the Strand Road provide railway and highway access to the main wharves and jetties. Plate 2 entitled, "Port of Rangoon," shows the aforementioned features and the approach channel of the Rangoon River.

2. PORT ADMINISTRATION

The Port of Rangoon is maintained and operated under the provisions of the Rangoon Port Act, 1905, by the Commissioners for the Port of Rangoon. The Commission, consisting of ten Commissioners headed by the Chairman, operates the port through its Departments of Traffic, Engineering (Civil), Engineering (Mechanical), Marine, Stores, Medical, Port Health and Port Police. It is responsible for maintaining, marking and lighting the entrance channel and the harbor; for pilotage of ships entering or leaving or moving within the harbor area; for providing and maintaining moorings, anchorages, public wharves, jetties and facilities pertaining thereto. It controls the movement of shipping, the loading and unloading of cargo on public wharves, and storage in transit sheds and warehouses. The lighterage within the port is handled by the Inland Water Transport Board and by the Rangoon Cargo Boat Owners Association.

3. WAR DAMAGE AND REHABILITATION

The Port of the City of Rangoon suffered greatly during the past war, from denial measures during evacuation in March 1942 and from military bombing from 1942 to 1945. The entire wharf and jetty area was damaged badly, and the cranes, pontoons and jetties were sunk in the river; sunken vessels and other wreckage prevented access to what remained of the wharves and jetties. Important dockyards, shops and other facilities were destroyed along with all warehouses and transit sheds. The lower reaches of the Rangoon River entrance channel and sea approaches were mined extensively; however, a channel with a maximum width of 3,000 ft. was swept of mines as the initial clearance of the harbor.

The rehabilitation of the Port of Rangoon was started immediately after the liberation of Burma, but it will be many years before complete rehabilitation can be realized. Upon return of the British in May 1945 immediate steps were taken to clear the waterfront, raise or remove sunken pontoons, cranes and other wreckage, and replace warehouses, pontoon jetties and other facilities with materials available, such as Army Nissen huts, Bailey bridges, Navy-assembled pontoons, and other temporary facilities. The port was put in operating condition in a remarkably short time, and in fiscal year 1947–48 handled more than 40% of prewar tonnage. Since 1948, all major reconstruction and rehabilitation measures have been curtailed by lack of funds. In 1949 and 1950, the Commissioners adopted a five-year program estimated to cost K4,39,49,000 and later revised that to a seven-year program which was estimated at K14,12,00,000. As yet very little progress has been realized. However, through the assistance programs of the United States, $2,624,330 (K1,24,65,570) have been received for materials and equipment for several pontoons and bridges, for transit sheds at the public wharves, for plant and tool equipment, and for tractors and trailers for handling cargo. In addition to the rehabilitation of the fixed structures the seven-year program includes principally the replacement of the flotilla required for port operation.

4. ENTRANCE CHANNEL

The sailing distance from the Gulf of Martaban to Monkey Point in the Port of Rangoon is about 21 nautical miles. The width of the channel from Elephant Point to the Port of Rangoon varies from 1,500 to 3,000 ft. and depths vary from 22 to over 500 ft., Mean Low Water Springs datum. The bar extends about ten nautical miles outside the entrance in all directions, and depths over the bar are approximately as follows:

About 18 ft. at Mean Low Water Springs.
About 23·5 ft. at Mean Low Water Neap.
About 32 ft. at Mean High Water Neap.
About 37 ft. at Mean High Water Springs.

There are no particular navigational hazards, and the channel is well lighted and marked; however, pilot service is required. The outer pilots take over the vessel about six miles out from the channel entrance, and bring the ship up the Rangoon River to about Middle Point. From there the vessel is brought to the berth by berthing pilots. At present there are 13 outer pilots and seven berthing pilots; and the quality of pilotage is good.

5. HARBOR AREA

The Port of Rangoon extends along part of the Rangoon and Pegu Rivers and Pazundaung Creek. The southern limit of the harbor is located about seven miles below Rangoon; the northern limit is about four nautical miles up Pazundaung Creek above its junction with the Rangoon River; the eastern limit is about 1·5 miles up the Pegu River; and the western limit is located where the Panhlaing and Hlaing Rivers join to form the Rangoon River, about seven miles upstream of the junction of the Rangoon and Pegu Rivers and Pazundaung Creek.

a. Hydrographic Conditions

From the western port and harbor limit to the entrance of the Twante Canal the depth of the channel is from 40 to 100 ft.; from the Twante Canal downstream for the next two miles the depth of the channel along the right bank or Dalla side varies from 25 to 30 ft. below low tide, and along the left bank or Rangoon side the depths in front of the wharves vary from 35 to 50 ft. As the river widens at its junction with the Pegu River and with Pazundaung Creek it gets progressively shallower, forming a bar opposite Monkey Point. Dredging is required in the Monkey Point Channel every day during the dry season to maintain a channel about 700 ft. wide, with depth of from 14 to 16 ft. below MLWS for access to Rangoon Harbor. During the rainy season the tidal flows maintain this channel by scouring action. The depths elsewhere in the harbor are generally ample at all stages of the tide for the movement or mooring of ships of any draft which can pass through the Monkey Point Channel.

The Commissioners operate a suction dredge mainly at Monkey Point Channel or in the approaches thereto. The annual dredging there and in the approaches during the period from 1922 to 1940 varied between 607,000 tons and 1,285,000 tons. In the fiscal year 1950–51 about 590,000 tons were dredged. Four bucket dredges of the Commissioners maintain the required depths along the wharves and pontoon jetties. They dredged a total of 372,000 tons in 1950–51. The bar at the entrance to Pazundaung Creek has less than seven ft. of water at low tide, but inside the bar the channel has depths of 18 to 30 ft. and widths of 200 to 500 ft.

The Seikgyi Training Wall is located on the right bank of Rangoon River, with its eastern terminal at the entrance to the Twante Canal. Following the arc of a circle, it extends for about 9,800 ft. to the point where the flow of Rangoon River starts to change its direction from south to east-southeast. The purpose of this wall is to direct the flow along the City wharves on the left bank. The King's Bank Training Wall is about 5,500 ft. long and is located at the right bank of Rangoon River opposite Monkey Point. It was constructed about 1928 for confining the ebb tide flows over the bar at Monkey Point Channel in order to increase the scouring effect. This wall narrows the width of flow over the bar from about 9,000 to 6,000 ft. The continuous building of shoals at the Monkey Point Channel indicates that the King's Bank Training Wall fails to produce a scouring action of sufficient strength.

The tidal range at the Port of Rangoon for the greatest ordinary spring tides is about 16·5 ft. and about nine ft. for mean neap tides. The tidal currents attain speeds up to six knots. During the monsoon season, from May to October, the ebb tides are so strong that vessels frequently will not turn to meet the flood tide.

b. Obstructions

There are many wrecks in and around the Port of Rangoon, but they do not interfere materially with the present commerce. Some have been removed already by the Commissioners. At least nine are on the Ahlone Shoal at the left bank opposite the Seikgyi Training Wall; nine more are near the shore along the right bank in front of the Dalla Dockyards; a sunken dredge is in the Twante Canal; two wrecks are in the mooring areas for large ships, one is opposite the William Street Jetty with a 24-ft. clearance at low water and one is opposite Judah Ezekiel Street with 23-ft. depth over it. Two electric cables of Rangoon Electric Tramway and Supply Company cross the Rangoon River just north of the Ahlone Wharf. The Pegu River is crossed by two electric cables of R.E.T. & S. Co. at the port and harbor limits and by the oil pipeline of the Burmah Oil Company. The only bridge in the harbor area is the Burma Railways bascule bridge which crosses the upper part of the Pazundaung Creek to Dawbon and is about one third nautical mile south of the port and harbor.

6. ANCHORAGES

The larger vessels are moored on free-swinging or fixed moorings in midstream of the Rangoon River approximately in the section between the entrance to the Twante Canal and the Botataung foreshore. Two free-swinging moorings are installed in the channel between Hastings Sands and the east bank of the Rangoon River and are used for loading ships to drafts greater than permitted to pass through Monkey Point Channel. In addition, there are two fixed berths for petroleum tankers along the east bank of the Rangoon River opposite Liffey Sands. Vessels carrying explosives are moored in the Rangoon River opposite Chokey Point. A special anchorage area near the mouth of the Pegu River is assigned to petroleum cargo lighters.

For the mooring of country craft, seagoing schooners and cargo boats the designated anchorage area is located in the Rangoon River north of the King's Bank Training Wall. There are over 40 smaller moorings for cargo boats scattered in the Rangoon River, mostly along the south bank in the reach between the entrance of the Twante Canal and the King's Bank Training Wall. Before the war there were moorings for about 30 large ships; at present there are about 22. The Commissioners contemplate the future installation of 16 additional sets (eight double sets). The locations of the aforementioned anchorage facilities are shown on Plate 2.

7. GENERAL CARGO WHARVES AND JETTIES

There are three public wharf sections which provide ten berths for deep-draft ships. Sule Pagoda Wharves section has seven berths, Brooking Street Wharves have two berths, and the Ahlone Wharf one berth. Ahlone Wharf has been assigned to the State Agricultural Marketing Board for the export of rice. Sule Pagoda berth No. 5 was destroyed during the war, and Sule Pagoda berths Nos. 6 and 7 have settled so much since 1931 from inadequate foundation conditions that they can only be used for lighterage operations; thus, there are only six berths available for the handling of general cargo. These wharves all approximate 500 ft. in length and present berthing spaces varying in length from 446 to 508 ft.

Three jetties or floating pontoons, Sule Pagoda No. 8 (Port Health Station) and Judah Ezekiel Street Nos. 1 and 2, can accommodate seagoing vessels. The jetties of the Commissioners for the Port of Rangoon at the Lanmadaw and Botataung foreshores are used principally by riverine craft, by schooners in the local coastwise trade, and by lighters transferring goods to and from ships anchored in midstream.

At the Lanmadaw foreshore there are 16 major pontoons and eight minor cargo-boat jetties; at the Botataung foreshore there are six major pontoons and two minor cargo-boat jetties; and in the section between the Sule Pagoda Wharves and Brooking Street Wharves there are three principal pontoons, one being Sule Pagoda berth No. 8, measuring 500 by 40 ft. These pontoons are of many sizes, varying from 80 by 10 ft. to 500 by 40 ft. Most of the pontoons are of the size 120 by 20 ft. and the newer types are 200 by 40 ft. All the pontoons are connected with the foreshores by hinged bridges to permit free vertical movement throughout the tidal range. Through ECA assistance materials were furnished for one 500-by-40-ft., five 200-by-40-ft. and ten 120-by-20-ft. pontoon jetties. Locations of these wharves and jetties are shown on Plates 3, 4, 5 and 6 entitled "Foreign Commerce Handling Facilities," "Proposed General Cargo Wharves," "Suggested Reconstruction—Lanmadaw Foreshore," and "Suggested Reconstruction—Botataung Foreshore."

8. TRANSIT SHEDS AND WAREHOUSES

The plates indicated in the preceding paragraph also show the locations of the general-cargo transit sheds and warehouses. In addition, Plate 7 entitled "Proposed Rice Wharves," shows the sheds at Ahlone Wharf (No. 1). Most of the sheds are served by sidings of the Burma Railways and by Strand Road which parallels the waterfront and provides highway access. Immediately after the war, nearly all transit sheds and warehouses erected were of the Nissen hut type. Since then, principally through the United States ECA program, transit sheds have been replaced by permanent type masonry buildings. At present there is a total of 303,500 sq. feet in transit-shed area, and 216,300 sq. ft. in warehouse accommodations. Warehouses represent 158,600 sq. ft. in Nissen huts which should be replaced at an early date, 47,700 sq. ft. of comparatively new steel-frame and sheet-metal buildings, and 10,000 sq. ft. of masonry building. The warehouses available in the areas of Sule Pagoda Wharves and Brooking Street Wharves which receive imported general cargo are actually not warehouses but are extensions of the transit sheds. Goods not removed from the transit sheds by the consignees prior to the start of unloading the next ship are moved to these warehouses where they are stored in the same conditions of demurrage as in the transit sheds. The warehouses of the Commissioners at the foreshores are used for storage of goods of riverine as well as of export commerce. Substantial areas are rented by the State Agricultural Marketing Board for storage of export rice. All warehouses at present consist either of Nissen huts or of one-story buildings with sheet-metal roofs and walls. These warehouses, particularly in the Lanmadaw foreshore area, are in need of early replacement. The approximate areas of these warehouses total about 745.980 sq. ft.; 363,760 sq. ft. are at the Lanmadaw foreshore, 214.680 sq. ft. at the Botataung foreshore and 167.540 sq. ft. at the former salt depot on Pazundaung Creek which now is used for civil supplies. Of the total area at the foreshores, Nissen huts cover 114.700 sq. ft., steel frame and sheet metal 440,980 sq. ft., masonry structures 177,340 sq. ft. and open shed 12,960 sq. ft.

9. CARGO-HANDLING EQUIPMENT

Before the war, Brooking Street and Sule Pagoda Wharves were well equipped with level luffing portal cranes with capacities varying from 1·5 to 3 tons; but all of these cranes either were badly damaged or destroyed. The present status indicates one 40-ton capacity traveling crane and the four two-ton level luffing cranes which were erected in 1952 and 1953. All cranes are at the Brooking Street Wharves. The four small cranes travel on trackways paralleling the wharf face; the large 40-ton crane can move only in a direction normal to the wharf face so that it not only has an extremely limited field of operation but occupies space badly needed for cargo-transit purposes. There are no cranes on the Sule Pagoda Wharves; however, the Commissioners plan to re-erect six 1·5-ton level luffing cranes which were salvaged from the river after the war, and to purchase nine new two- or three-ton level luffing traveling portal cranes in the period from 1956 to 1958 as indicated by their present seven-year program.

All stacking of cargo in the transit sheds is by hand. For handling of cargo and transfer between shipside and transit shed, the Traffic Department assigns equipment from a central pool to the various berths when needed. The Commissioners' equipment includes six steam locomotive cranes of five-ton capacity, 40 crawler cranes and rubber-tired cranes of two- to eight-ton capacity with one of 15-ton capacity, nine Fordson two-ton tractors, 20 gasoline one-ton tractors, 18 electric one-ton tractors with trailers, about 105 platforms and trailers, and about 100 hand-trucks and wheelbarrows. Most of the equipment, particularly the cranes, is old but in fair condition. Gantries of ten-ton capacity and a track gauge of 70 ft. are used in the open storage areas at the Brooking Street and Sule Pagoda Wharves.

10. FACILITIES FOR SHIPBUILDING AND MARINE REPAIR

The principal dockyards and marine repair units at the Port of Rangoon are described in the following paragraphs. The locations of the various installations are shown on Plate 2.

a. The Dalla Dockyard

The Dalla Dockyard of the Inland Water Transport Board is located opposite the city of Rangoon, at the right bank of the river. It covers an area of about 52 acres and has ample space for extension. The dockyard is well equipped with shops, 13 slipways, and one wet dock. The capacity of slipways varies from one 50-ton craft to two 500-ton craft. Slipways Nos. 7 to 12 have six carriages, capable of taking 200 tons each; they are designed to haul sideways a ship of 1,200 tons, up to about 250 ft. in length. The wet dock has a length of keel blocks of 220 ft. and width of entrance of 47 ft. 3 in. at the seven-foot tide mark. It is capable of taking craft not exceeding 230 ft. in length, of approximately 1,000 gross tons.

b. The Rangoon Foundry

The Rangoon Foundry on the left bank of the river, is an annex of Dalla Dockyard. It has machine shops, plating and copper shops, foundry, and four slipways, two of which are 100 ft. long and two 80 ft. long. The slipways each can accommodate two launches 94·5 ft. long or three cargo boats up to 450 tons each.

c. The Government Dockyard

The Government Dockyard is located on the left bank of Pazundaung Creek at Dawbon and is operated under the direction of the Nautical Adviser and Principal Officer, Mercantile Marine Department. The dockyard has good shops and slipways, and is used for the repair and construction of government craft including small naval vessels. Its present capacity is inadequate to handle expeditiously the many craft awaiting repairs, but space is available for the construction of additional slipways.

d. Work Shops

The Port of Rangoon Work Shops are located on the left bank of the Rangoon River just east of the Brooking Street Wharves; they include shops and slipways capable of handling vessels up to 100 ft. in length and a chain test house.

e. Kahn's Dry Dock

Kahn's Dry Dock is the only dry dock in Rangoon. It is located on the right bank of Pazundaung Creek, about two miles above the mouth. It is privately owned and was built originally for the repair of cargo boats and lighters used by Kahn's Rice Mills Company. The length of the dock is 243 ft. 7 in., the width of entrance 50 ft. 2 in., and the top of gate sill is about 12 feet below Mean High Water Springs tides and approximately 6·5 ft. above Mean Low Water Springs; therefore, docking of vessels is possible during high tides only and tidal conditions limit considerably the usefulness of this dock. There are no shops available at this unit nor is the dock equipped with cranes.

11. COMMISSIONERS' HARBOR CRAFT

The flotilla of the Marine Department of the Commissioners for the Port of Rangoon includes a suction dredge, a salvage vessel, a buoy vessel (on loan), a pilot vessel, four tugs, a fireboat, ten launches, two beacon motorboats and miscellaneous other craft. The floating equipment of the Civil Engineering Department includes four bucket cranes or dredges, eight hopper barges, two pile barges, three working barges, three jetty-bridge lifting barges, and other miscellaneous craft and floating equipment. Most of the equipment is either in need of immediate replacement or only in fair condition. The rehabilitation of the Commissioners' flotilla is included in their seven-year program.

12. LABOR SUPPLY

At present all stevedores, with the exception of those handling coal, are organized in the Dock Labor Board Employees Union. This personnel is furnished by the Dock Labor Board which was organized and began functioning in February 1952. The coal handling stevedores are organized in the Coal Workers Loading and Unloading Cooperative Society. Both of these stevedoring unions are sponsored by the Trade Union Congress of Burma which supports Government. The Coal and Coke Agency handles all imported coal in Rangoon and hires the stevedores from the Coal Workers Loading and Unloading Cooperative Society when needed. Some of the dock labor employed by the Traffic Department of the Commissioners for the Port of Rangoon at the wharves (particularly dockers on monthly pay), as well as part of the contractors' coolie labor used by the State Agricultural Marketing Board in the rice commerce and by other organizations and enterprises, are organized in the Port Workers Cooperative Union, a non-political organization. Other dock labor is included in the Dock Workers Cooperative Society, sponsored by the Burma Trade Union Congress, which is alleged to have communistic orientation.

At the Dock Labor Board there are registered at present about 1,400 stevedores with guaranteed minimum wages for 14 days per month and calling fees. In addition, there are registered about 1,200 casual stevedores. The Coal Workers Loading and Unloading Cooperative Society has a membership of about 200, but generally cannot supply more than eight gangs of 18 men each. At present there are employed by the

Traffic Department of the Commissioners for the Port of Rangoon about 30 working foremen and 420 dockers on a monthly pay basis, and about 40 foremen and 560 dockers who are registered as casuals on daily pay. During the month of September 1952 the casuals worked about 16 or 17 days. The contractors working at the coal yard of the Coal and Coke Agency employ permanently about 180 coolies in three gangs of about 60 men. The contractors' labor, handling coal in the yards of Burma Railways, is employed as needed. For the handling of rice on shore the State Agricultural Marketing Board employs three contractors with an average of 700 to 1,000 coolies daily, and much more during periods of extensive rice shipping. The loading of timber into lighters is handled by the labor of the saw mills.

The loading and unloading of ships, except cargoes of coal and petroleum, are handled by eight private stevedoring companies who are working under contract either with the shipping agencies or directly with ship owners. These companies daily hire the required number of stevedores from the Dock Labor Board and provide their own supervisors who are permanent employees. The Coal and Coke Agency does not provide its own supervisory personnel on the ships, but does provide them at the storage yard. The dock labor at the wharves is supervised by permanent employees of the Traffic Department. The dock labor on shore handling rice, coal and other products of riverine trade is contractors' coolie labor.

Before the war most of the stevedoring and dock laborers were South Indians. The coal-handling labor at present also is predominantly comprised of South Indians. Since it is the policy of Government to utilize nationals insofar as possible in the labor forces these South Indians are being replaced by Burmans. At present the stevedore and dock labor forces contain approximately 50% Burmans and 50% South Indians. As all cargo now is essentially moved and stacked by hand, the efficiency of cargo handling operations is dependent on the general efficiency and ability of the coolie labor.

Prior to the war all cargo was handled in two ten-hour shifts per day. At present, for stevedores working on ships in the stream, the hours are from 7 a.m. to 4 p.m. with one hour rest period in the first shift, and from 7 p.m. to 3 a.m. In most cases some overtime is worked between 4 p.m. and 6 p.m. and between 3 a.m. and 6 a.m. with a net working time of 17 to 18 and up to 21 hours in two shifts. Stevedores and dock labor usually work at the wharves from 6 a.m. to 2 p.m. and from 2 p.m. to 10 p.m. with one half-hour interval in each shift. Generally the stevedores work some overtime after 10 p.m. Coolie labor handling coal at the yard of the Coal and Coke Agency usually works from sunrise to sunset. Coolie labor of the State Agricultural Marketing Board handling rice usually works one eight-hour day shift, from 7 a.m. to noon and from 1 p.m. to 4 p.m.

Stevedores, except those engaged in handling coal and petroleum, receive K7.50 per shift for working foremen, K4.25 per shift for winchmen, and K3.94 per shift for stevedore labor. For stevedores handling coal, the Coal and Coke Agency pays the Coal Workers Loading and Unloading Cooperative Society K1.00 per ton, out of which the stevedores receive directly K0.12 for their gear, overhead and other costs and the remaining K0.88 is paid to the Society for distribution among its members. The dock laborers of the Traffic Department of the Commissioners receive the following remuneration:

Daily paid: Foreman—K2.31 plus cost of living K2.
Dockers—K1.94 plus cost of living K1.87.
Monthly paid: Foremen—K60 to K70 plus cost of living K51.50 to K56.75.
Dockers—K50 to K60 plus cost of living K47.00 to K51.50.

Overtime rates are provided only for those on monthly pay, and extra pay is given for the handling of dirty cargoes to both classes. Contractors' coolie labor earns about K3.00 or less per day for handling various cargoes on shore.

13. COMMERCE

In order to indicate clearly the prewar and postwar shipping and commerce, seven tables are included as Table XII—1 to 6 and 4A (*see pp. 287–89 and 296*).

14. CARGO HANDLING

a. Import General Cargo

Import general cargo at present represents over 60% of the foreign trade. All general cargo is unloaded at two public wharves, Brooking Street Wharves and Sule Pagoda Wharves, having a total of six berths in operating condition. Four wharf cranes are available at present at Brooking Street Wharves. Elsewhere the unloading from ship to wharf is by ship's gear only. The cargo is transferred from the wharf to warehouse by means of wheelbarrows, electric tractors and trailers and similar equipment. No fork-lift trucks, pallets and racks are used, and the stacking of goods in transit sheds is entirely by hand. In the transit sheds the goods are sorted out, processed through the customs, and then loaded by the consignees on trucks and railway cars for transport to destination. Trucks are used predominantly.

TABLE XII – 1

NUMBER OF VESSELS CLASSIFIED AS TO GROSS TONNAGE ARRIVING AT, AND DEPARTING FROM, THE PORT OF RANGOON

	Steamers													
Year	*Under 1,000 tons*	*1,001 to 2,000*	*2,001 to 3,000*	*3,001 to 4,000*	*4,001 to 5,000*	*5,001 to 6,000*	*6,001 to 7,000*	*7,001 to 8,000*	*8,001 to 9,000*	*9,001 to 10,000*	*Above 10,000*	*Total*	*Sailing Vessels*	*Grand Total*
Arrivals														
1946–47	61	31	38	74	82	97	80	91	29	41	27	651	947	1,598
1947–48	38	47	18	81	96	81	57	138	29	14	8	607	811	1,418
1948–49	73	22	4	115	42	70	31	127	35	1	7	527	1,135	1,662
1949–50	70	2	18	95	81	75	41	79	44	4	8	517	1,095	1,612
1950–51	66	21	5	90	76	70	42	64	44	5	10	493	1,311	1,804
1951–52	80	40	25	84	56	85	53	56	55	5	14	553	1,046	1,599
Departures														
1946–47	64	31	38	73	82	98	80	88	29	42	27	652	889	1,541
1947–48	39	48	20	82	98	83	57	143	29	14	8	621	790	1,411
1948–49	66	22	4	115	43	70	31	123	36	1	7	518	1,127	1,645
1949–50	69	2	18	97	81	74	41	77	44	4	8	515	1,082	1,597
1950–51	66	21	5	90	75	70	42	67	44	5	9	494	1,306	1,800
1951–52	81	39	26	83	59	84	53	55	58	5	15	558	1,049	1,607

TABLE XII – 2

NUMBER, GROSS AND NET TONNAGE OF VESSELS ARRIVING AT, AND DEPARTING FROM, THE PORT OF RANGOON

Year	*Number*			*Gross Tonnage*			*Net Tonnage*		
	Steamers	*Sailing Vessels*	*Total*	*Steamers*	*Sailing Vessels*	*Total*	*Steamers*	*Sailing Vessels*	*Total*
Arrivals									
1946–47	651	947	1,598	3,540,021	54,620	3,594,641	2,048,401	46,837	2,095,238
1947–48	607	811	1,418	3,173,812	50,753	3,224,565	1,828,736	42,336	1,871,072
1948–49	527	1,135	1,662	2,602,915	75,957	2,678,872	1,510,568	62,644	1,573,212
1949–50	517	1,095	1,612	2,572,044	77,424	2,649,468	1,491,412	58,153	1,549,565
1950–51	493	1,311	1,804	2,426,501	110,210	2,536,711	1,434,993	76,190	1,511,183
1951–52	553	1,046	1,599	2,640,148	101,157	2,741,305	1,542,213	67,000	1,609,213
Departures									
1946–47	652	889	1,541	3,531,885	52,239	3,584,124	2,041,935	44,859	2,086,794
1947–48	621	790	1,411	3,241,265	48,272	3,289,537	1,869,937	40,381	1,910,318
1948–49	518	1,127	1,645	2,591,463	76,916	2,668,379	1,507,115	61,913	1,569,028
1949–50	515	1,082	1,597	2,558,882	76,854	2,635,736	1,482,374	57,671	1,540,045
1950–51	494	1,306	1,800	2,434,661	109,797	2,544,458	1,437,427	75,669	1,513,096
1951–52	558	1,049	1,607	2,672,438	101,930	2,744,368	1,560,349	67,381	1,627,730

The stevedoring work is performed by private stevedoring companies; the dock labor is employed by the Commissioners' Traffic Department. A stevedoring gang for handling general cargo consists of one working foreman, two winchmen and 12 stevedores, a total of 15 men; a dock labor gang consists of one working foreman and 14 men.

In the last prewar fiscal year 1940–41, with a total volume of foreign trade of 4,947,000 tons, the maximum tonnage which possibly could be handled at the wharves was:

Imported General Cargo	958,000 tons
Exported Minerals	72,000 ,,
Exported general cargo, about	170,000 ,,
	1,200,000 ,,

On the basis of seven wharves in operation (Sule Pagoda berths Nos. 1 to 5 and Brooking Street berths Nos. 1 and 2), the average rate of handling import general cargo was about 170,000 tons per wharf per year.

The working schedule was two shifts of ten hours each in the prewar period, and the average rate of cargo handling probably did not exceed seven to eight tons per hatch per hour, or about 700 to 800 tons per ship per day. (This latter figure can be derived also from the comparison of present with prewar average turn-around times of vessels. With seven berths in operation, the average number of working days per year was about 245 days or about 82% of berth occupancy.)

It may be concluded that the over-all efficiency of cargo handling was relatively good, but it was achieved at the cost of working the stevedores practically around the clock, and with a high percentage of berth occupancy, leaving practically no time reserve for the periods of concentration of ship arrivals. Such practices should be avoided as they lead to congestions and delays in discharge of ships. It is understood that in the busy prewar period vessels with import cargo for the wharves had to be kept out in the stream waiting for a berth, just as much through lack of warehouse accommodations as through shortage of berths. It can therefore be considered that the berthage and warehouse accommodations available before the war were quite insufficient for smooth and orderly port operations.

At present, the average rate of import cargo handling does not exceed 450 tons per ship per day in two eight-hour shifts, or approximately five to six tons per

TABLE XII – 3

PREWAR SEABORNE TRADE IN THE PORT OF RANGOON

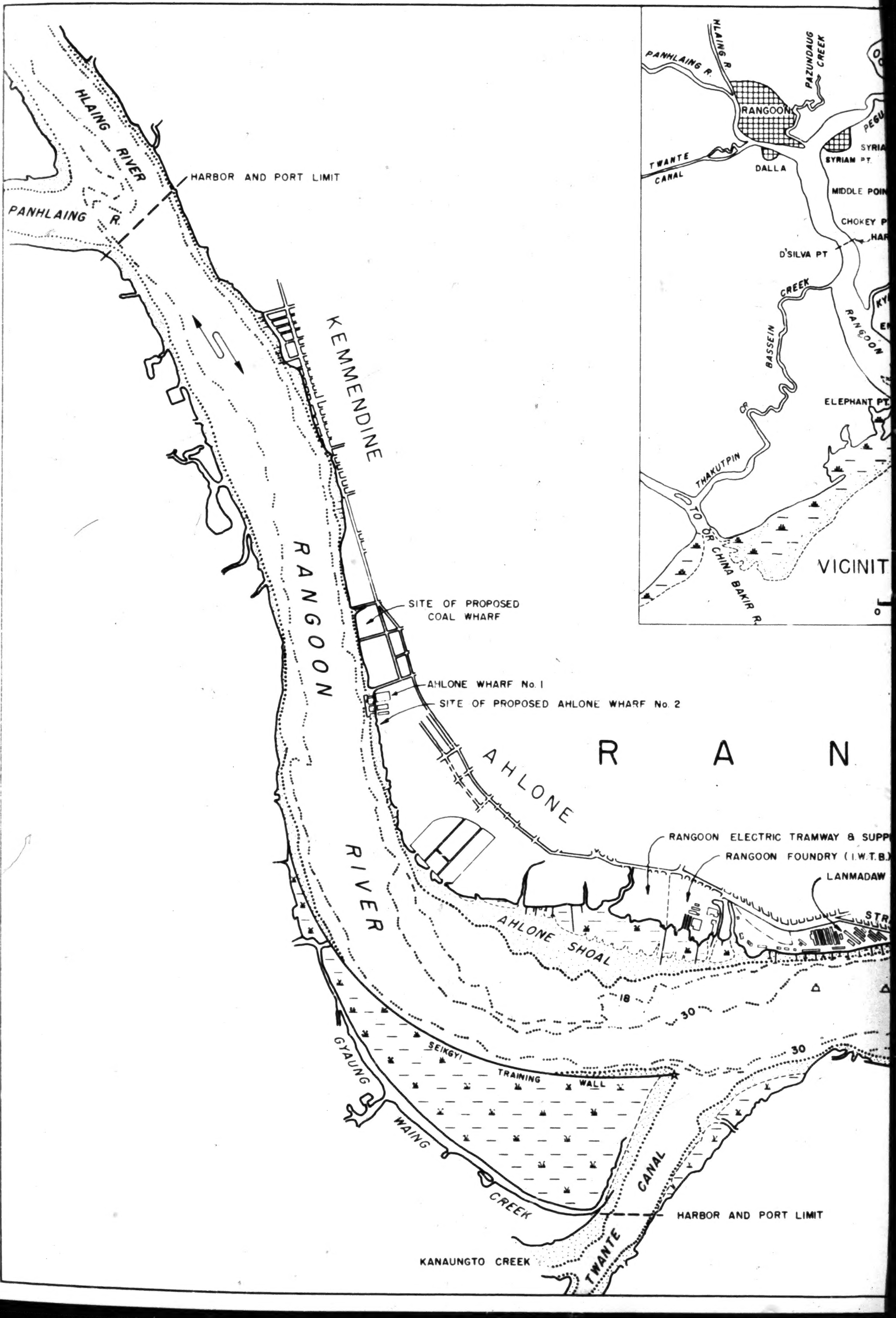
(thousands of tons)

	1936	*1937*	*1938*	*1939*
Imports	1,325·5	1,318·9	1,430·2	1,400·3
Exports	3,891·1	3,940·1	3,959·8	3,579·2
Transhipment	23·9	29·1	28·6	26·6
Total	5,240·5	5,288·1	5,418·6	5,006·1

TABLE XII – 4

SEABORNE TRADE IN 1946–51

Description of Trade	*1946–47* *(tons)*	*1947–48* *(tons)*	*1948–49* *(tons)*	*1949–50* *(tons)*	*1950–51* *(tons)*	*1951–52* *(tons)*
(*a*) Seaborne Trade						
Imports	836,774	823,623	513,305	532,853	650,856	768,200
Exports	911,083	1,214,034	969,939	857,267	1,260,775	1,140,900
Transhipment	2,753	4,352	3,039	5,121	4,514	1,714
Total	1,750,610	2,042,009	1,486,283	1,395,241	1,916,145	1,910,814
(*b*) Proportion handled over Commissioners' premises						
Imports	566,363	482,414	309,628	316,070	424,448	505,265
Exports	338,514	534,169	317,400	322,546	558,694	580,105
Transhipment	556	1,049	739	1,319	579	229
Total	905,433	1,017,632	627,767	639,935	983,721	1,085,599


HLAING RIVER
HARBOR AND PORT LIMIT
PANHLAING R.
KEMMENDINE
RANGOON
SITE OF PROPOSED COAL WHARF
AHLONE WHARF No. 1
SITE OF PROPOSED AHLONE WHARF No. 2
AHLONE
R A N
RIVER
RANGOON ELECTRIC TRAMWAY & SUPP
RANGOON FOUNDRY (I.W.T.B.)
LANMADAW
STR
AHLONE SHOAL
18
30
30
SEIKGYI TRAINING WALL
GYAUNG WAING CREEK
TWANTE CANAL
HARBOR AND PORT LIMIT
KANAUNGTO CREEK
HLAING R.
PANHLAING R.
PAZUNDAUG CREEK
RANGOON
PEGU
SYRIA
TWANTE CANAL
DALLA
SYRIAM PT.
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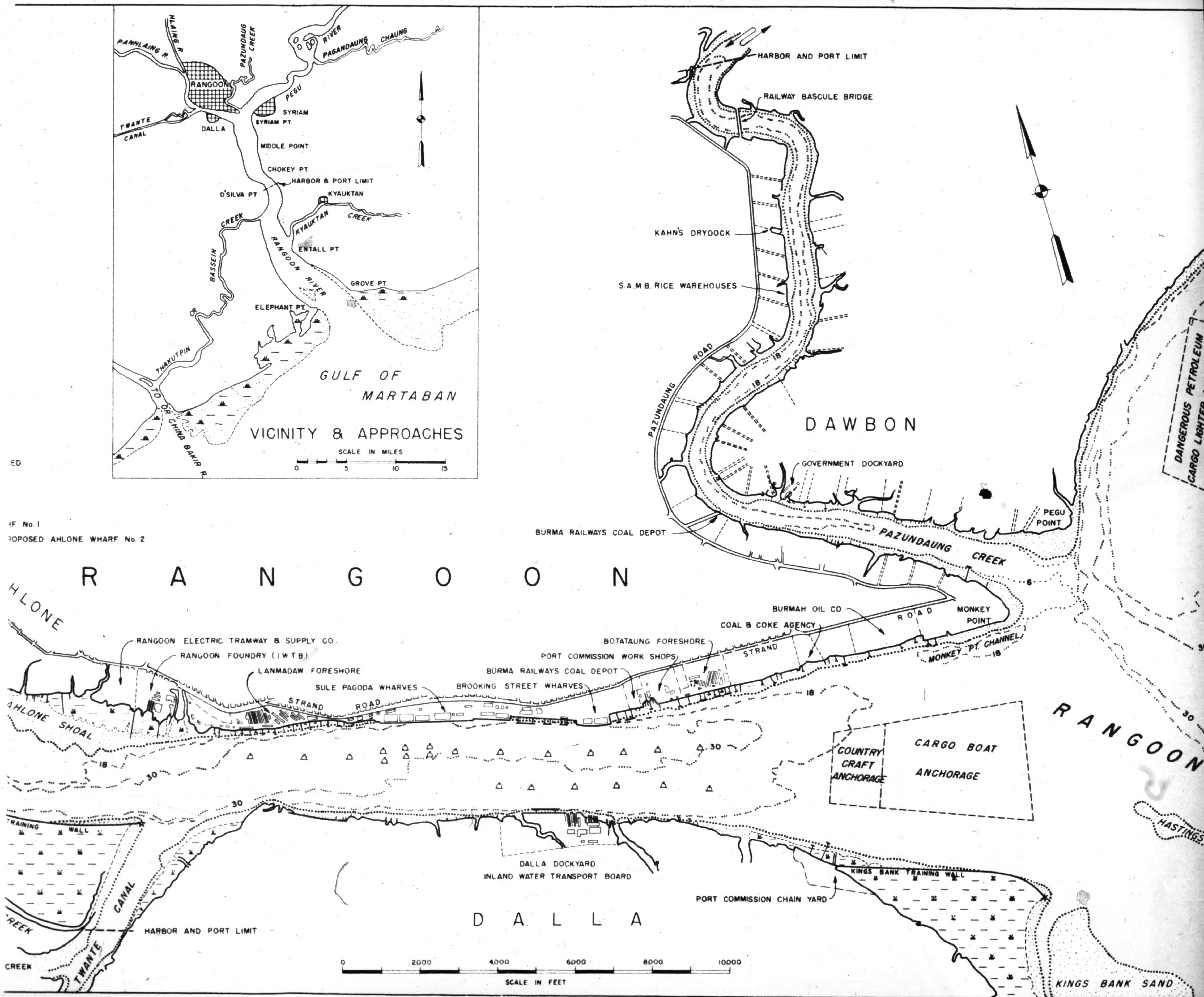
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SYRIAM PT.
MIDDLE POINT
CHOKEY PT.
HARBOR & PORT LIMIT
D'SILVA PT.
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BASSEIN CREEK
RANGOON RIVER
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KAHN'S DRYDOCK
S.A.M.B. RICE WAREHOUSES
PAZUNDAUNG ROAD
18
DAWBON
GOVERNMENT DOCKYARD
PEGU POINT
BURMA RAILWAYS COAL DEPOT
PAZUNDAUNG CREEK
6
DANGEROUS PETROLEUM CARGO LIGHTER
ED
IF No. 1
ROPOSED AHLONE WHARF No. 2
RANGOON
HLONE
BURMAH OIL CO.
COAL & COKE AGENCY
MONKEY POINT
ROAD
RANGOON ELECTRIC TRAMWAY & SUPPLY CO.
RANGOON FOUNDRY (I.W.T.B.)
BOTATAUNG FORESHORE
PORT COMMISSION WORK SHOPS
STRAND
MONKEY PT. CHANNEL
LANMADAW FORESHORE
BURMA RAILWAYS COAL DEPOT
SULE PAGODA WHARVES
BROOKING STREET WHARVES
STRAND ROAD
AHLONE SHOAL
30
RANGOON
COUNTRY CRAFT ANCHORAGE
CARGO BOAT ANCHORAGE
TRAINING WALL
HASTINGS
DALLA DOCKYARD
INLAND WATER TRANSPORT BOARD
KINGS BANK TRAINING WALL
PORT COMMISSION CHAIN YARD
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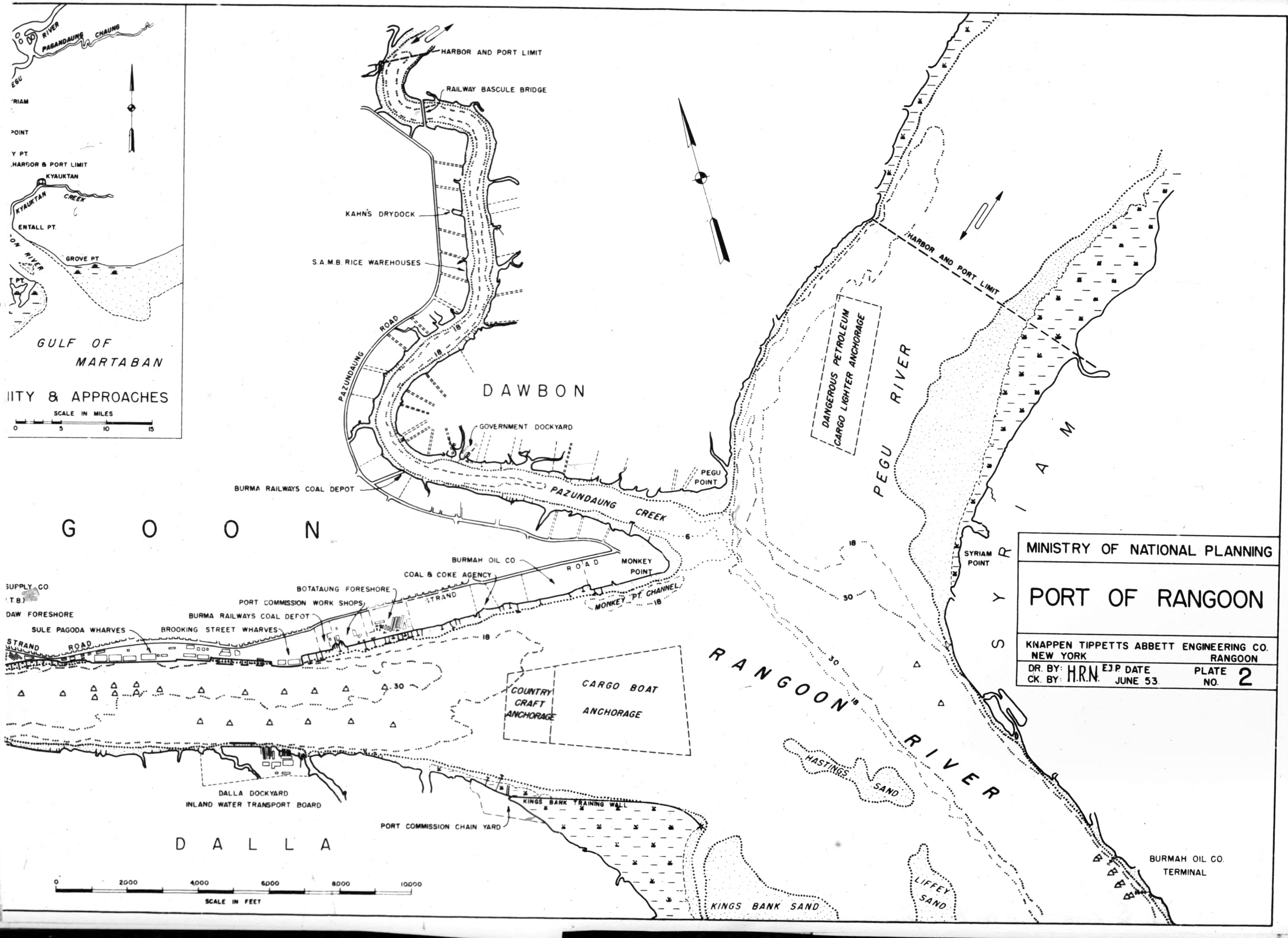
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KAHN'S DRYDOCK
S.A.M.B. RICE WAREHOUSES
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DAWBON
GOVERNMENT DOCKYARD
BURMA RAILWAYS COAL DEPOT
PAZUNDAUNG CREEK
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COAL & COKE AGENCY
ROAD
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DAW FORESHORE
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BROOKING STREET WHARVES
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CARGO BOAT ANCHORAGE
DALLA DOCKYARD
INLAND WATER TRANSPORT BOARD
KINGS BANK TRAINING WALL
PORT COMMISSION CHAIN YARD
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6000
8000
10000
SCALE IN FEET
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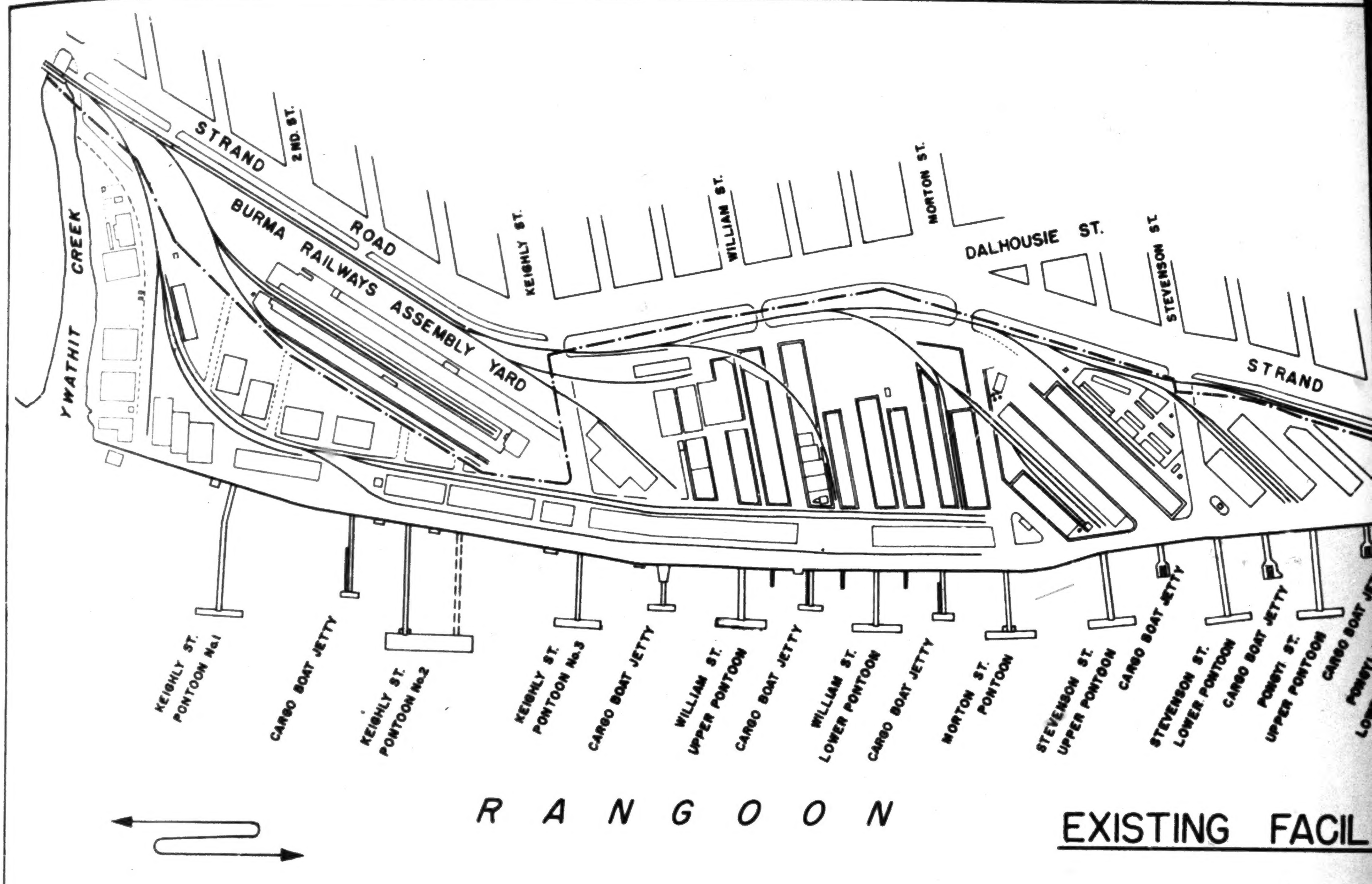
LIFFEY SAND
HASTINGS SAND
RANGOON RIVER
DANGEROUS PETROLEUM CARGO LIGHTER ANCHORAGE
PEGU RIVER
HARBOR AND PORT LIMIT
SYRIAM
SYRIAM POINT
BURMAH OIL CO. TERMINAL

MINISTRY OF NATIONAL PLANNING

PORT OF RANGOON

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY: H.R.N. E.J.P. DATE PLATE
CK. BY: H.R.N. JUNE 53. NO. 2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BURMA RAILWAYS ASSEMBLY YARD
KEIGHLY ST. PONTOON No.1
CARGO BOAT JETTY
KEIGHLY ST. PONTOON No.2
KEIGHLY ST. PONTOON No.3
CARGO BOAT JETTY
WILLIAM ST. UPPER PONTOON
CARGO BOAT JETTY
WILLIAM ST. LOWER PONTOON
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MORTON ST. PONTOON
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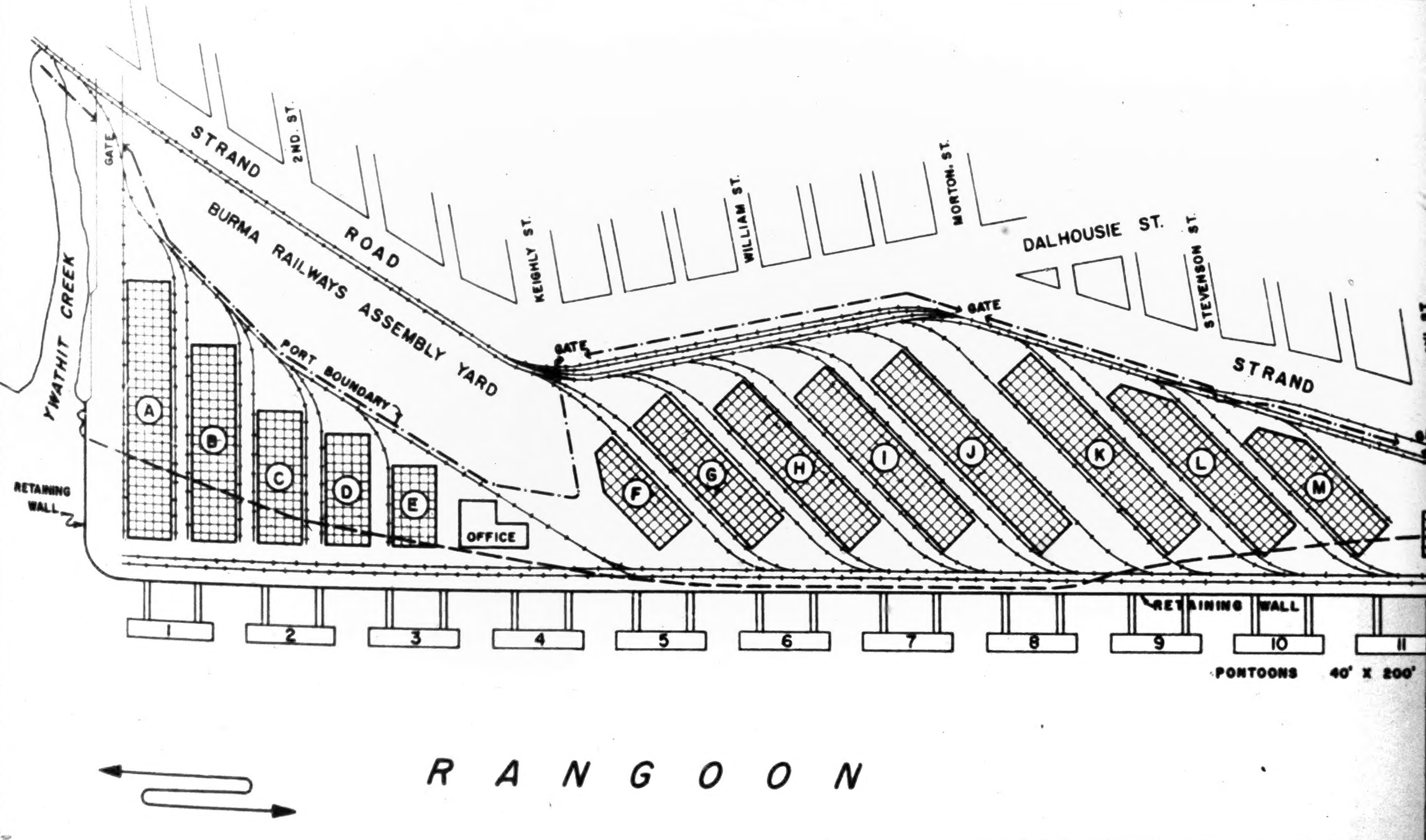
EXISTING FACIL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GATE
YWATHIT CREEK
BURMA RAILWAYS ASSEMBLY YARD
PORT BOUNDARY
RETAINING WALL
RETAINING WALL
OFFICE
A
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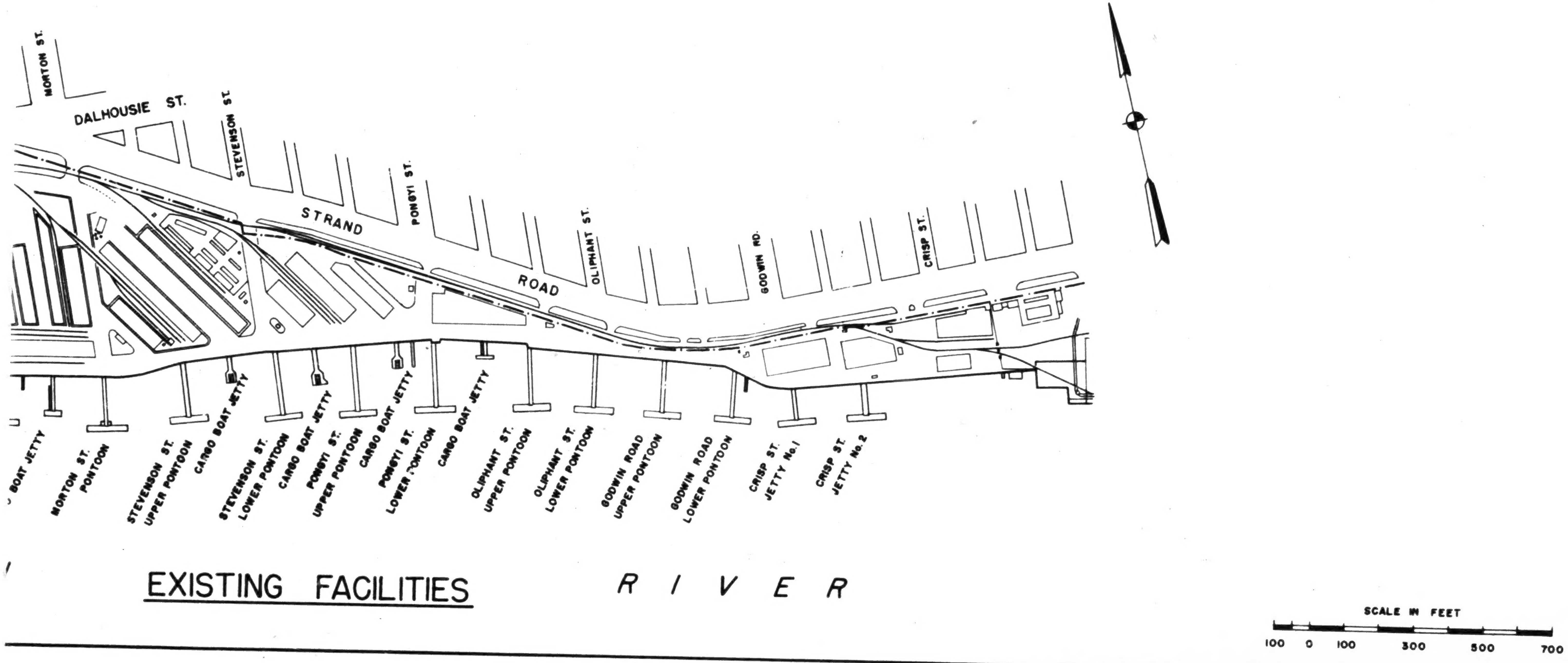
11
PONTOONS 40' X 200'
RANGOON

SUGGESTED RECONS


MORTON ST.
DALHOUSIE ST.
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OLIPHANT ST.
GODWIN RD.
CRISP ST.
BOAT JETTY
MORTON ST. PONTOON
STEVENSON ST. UPPER PONTOON
CARGO BOAT JETTY
STEVENSON ST. LOWER PONTOON
CARGO BOAT JETTY
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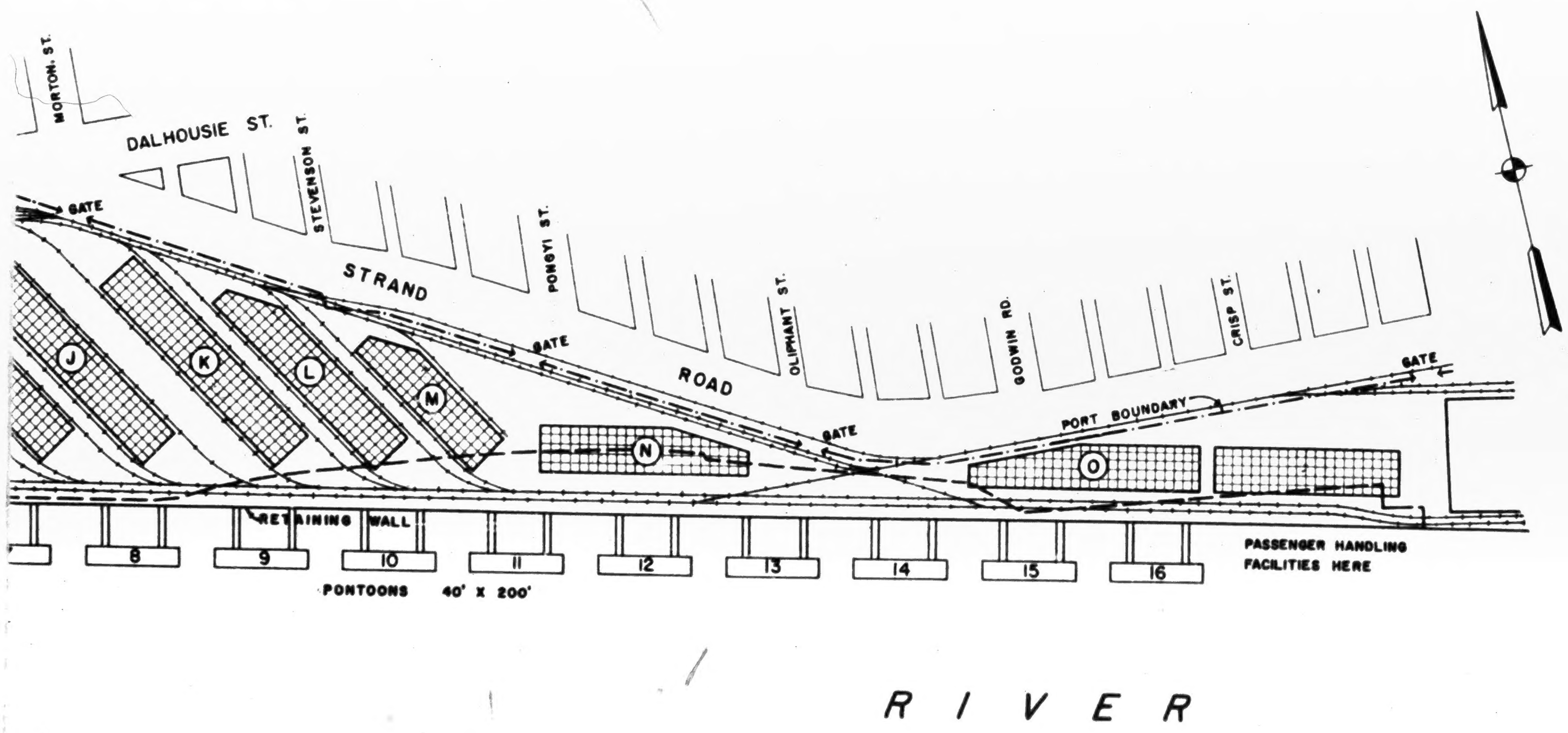
OLIPHANT ST. LOWER PONTOON
GODWIN ROAD UPPER PONTOON
GODWIN ROAD LOWER PONTOON
CRISP ST. JETTY No. 1
CRISP ST. JETTY No. 2
R I V E R
SCALE IN FEET
100 0 100 300 500 700

EXISTING FACILITIES


MORTON. ST.
DALHOUSIE ST.
STEVENSON ST.
PONGYI ST.
OLIPHANT ST.
GODWIN RD.
CRISP ST.
STRAND
ROAD
GATE
GATE
GATE
GATE
PORT BOUNDARY
J
K
L
M
N
O
RETAINING WALL
8
9
10
11
12
13
14
15
16
PONTOONS 40' X 200'
PASSENGER HANDLING FACILITIES HERE
R I V E R

SUGGESTED RECONSTRUCTION

No.	NAME	SIZE
A	TRANSIT SHED WAREHOUSE	100' X 580'
B	DO.	100' X 440'
C	DO.	100' X 300'
D	DO.	100' X 260'
E	DO.	100' X 180'
F	DO.	100' X 260'
G	DO.	100' X 380'
H	DO.	100' X 440'
I	DO.	100' X 480'
J	DO.	100' X 540'
K	DO.	100' X 540'
L	DO.	100' X 500'
M	DO.	100' X 360'
N	DO.	100' X 480'
O	DO.	100' X 500'

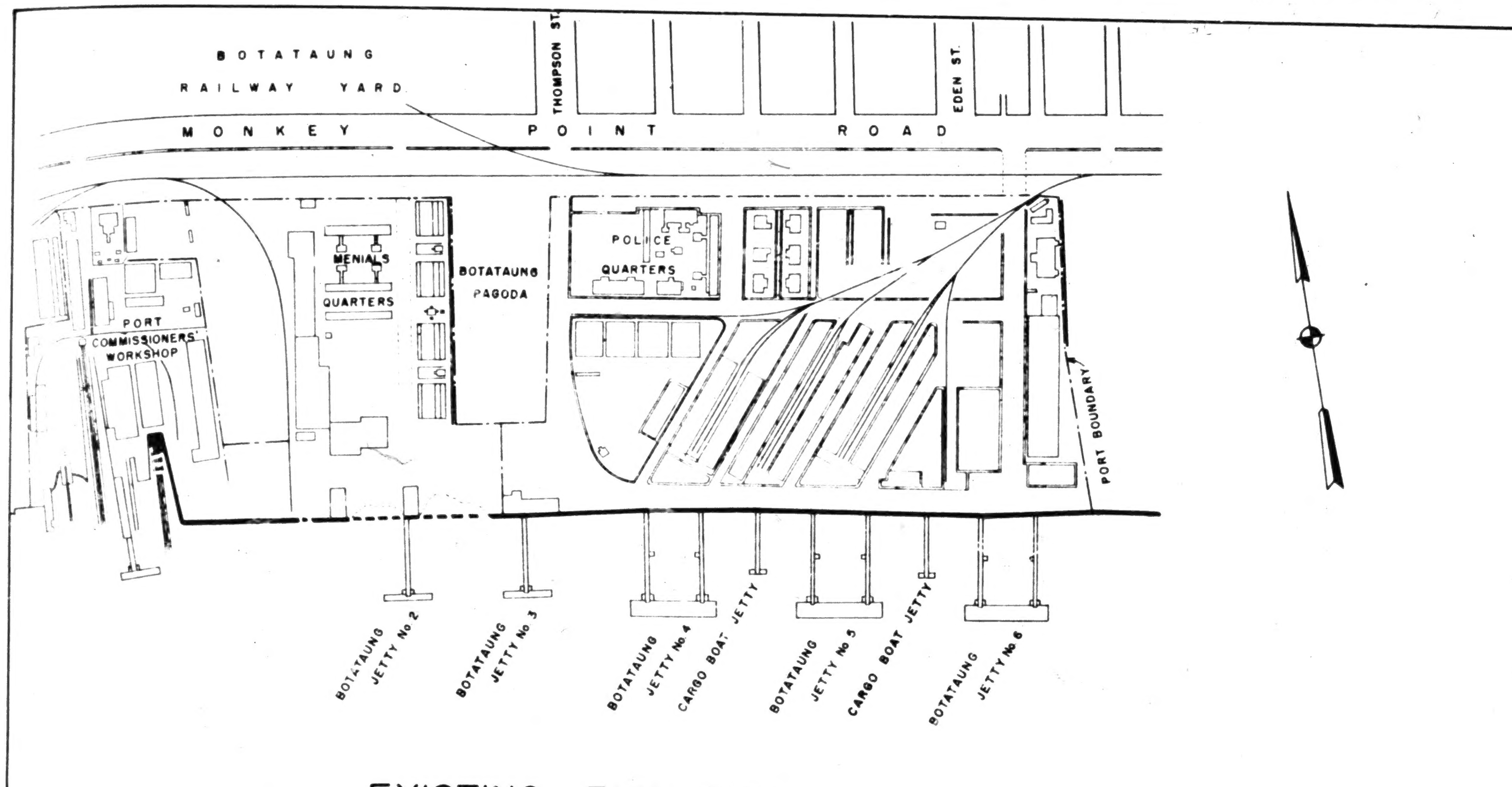
SCALE IN FEET
100 0 100 300 500 700

MINISTRY OF NATIONAL PLANNING

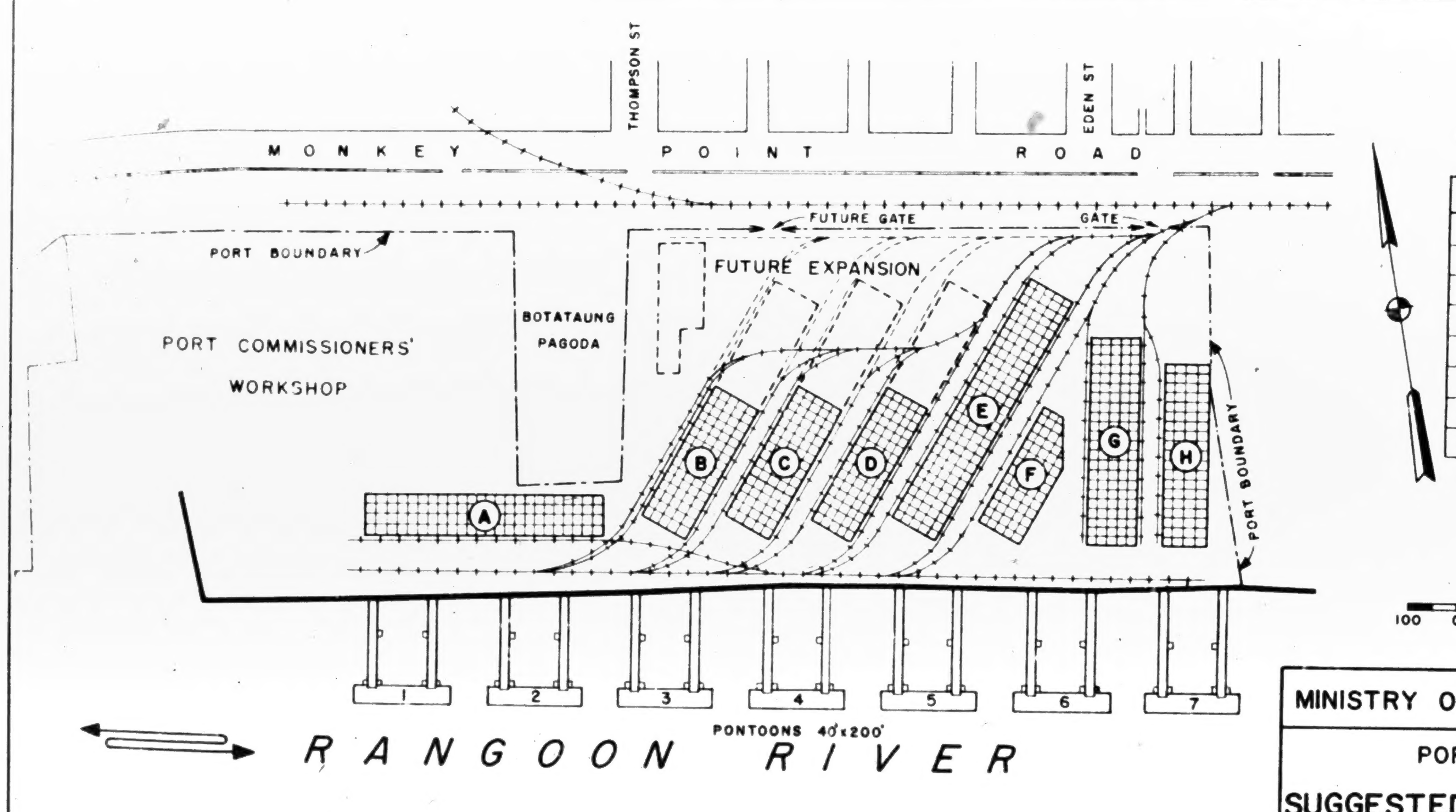
PORT OF RANGOON
SUGGESTED RECONSTRUCTION
LANMADAW FORESHORE

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY: HRN EJP DATE
CK. BY: H.R.N. JUNE 53.
PLATE NO. 3


BOTATAUNG RAILWAY YARD
MONKEY POINT ROAD
THOMPSON ST.
EDEN ST.
PORT COMMISSIONERS' WORKSHOP
MENIALS QUARTERS
BOTATAUNG PAGODA
POLICE QUARTERS
PORT BOUNDARY
BOTATAUNG JETTY No 2
BOTATAUNG JETTY No 3
BOTATAUNG JETTY No 4
CARGO BOAT JETTY
BOTATAUNG JETTY No 5
CARGO BOAT JETTY
BOTATAUNG JETTY No 6
SCALE.- IN FEET.
100 0 100 300 500

EXISTING FACILITIES


THOMPSON ST
EDEN ST
MONKEY POINT ROAD
FUTURE GATE
GATE
PORT BOUNDARY
FUTURE EXPANSION
BOTATAUNG PAGODA
PORT COMMISSIONERS' WORKSHOP
A
B
C
D
E
F
G
H
PORT BOUNDARY
1
2
3
4
5
6
7
PONTOONS 40'x200'
RANGOON RIVER
SCALE.- IN FEET.
100 0 100 300 500

No	NAME	INITIAL	FUTURE
A	TRANSIT SHED WAREHOUSE	100' x 500'	–
B	DO.	100' x 300'	100' x 560'
C	DO.	100' x 300'	100' x 560'
D	DO	100' x 320'	100' x 560'
E	DO.	100' x 580'	–
F	DO.	100' x 280'	–
G	DO	100' x 440'	–
H	DO	100' x 380'	

SUGGESTED RECONSTRUCTION

MINISTRY OF NATIONAL PLANNING

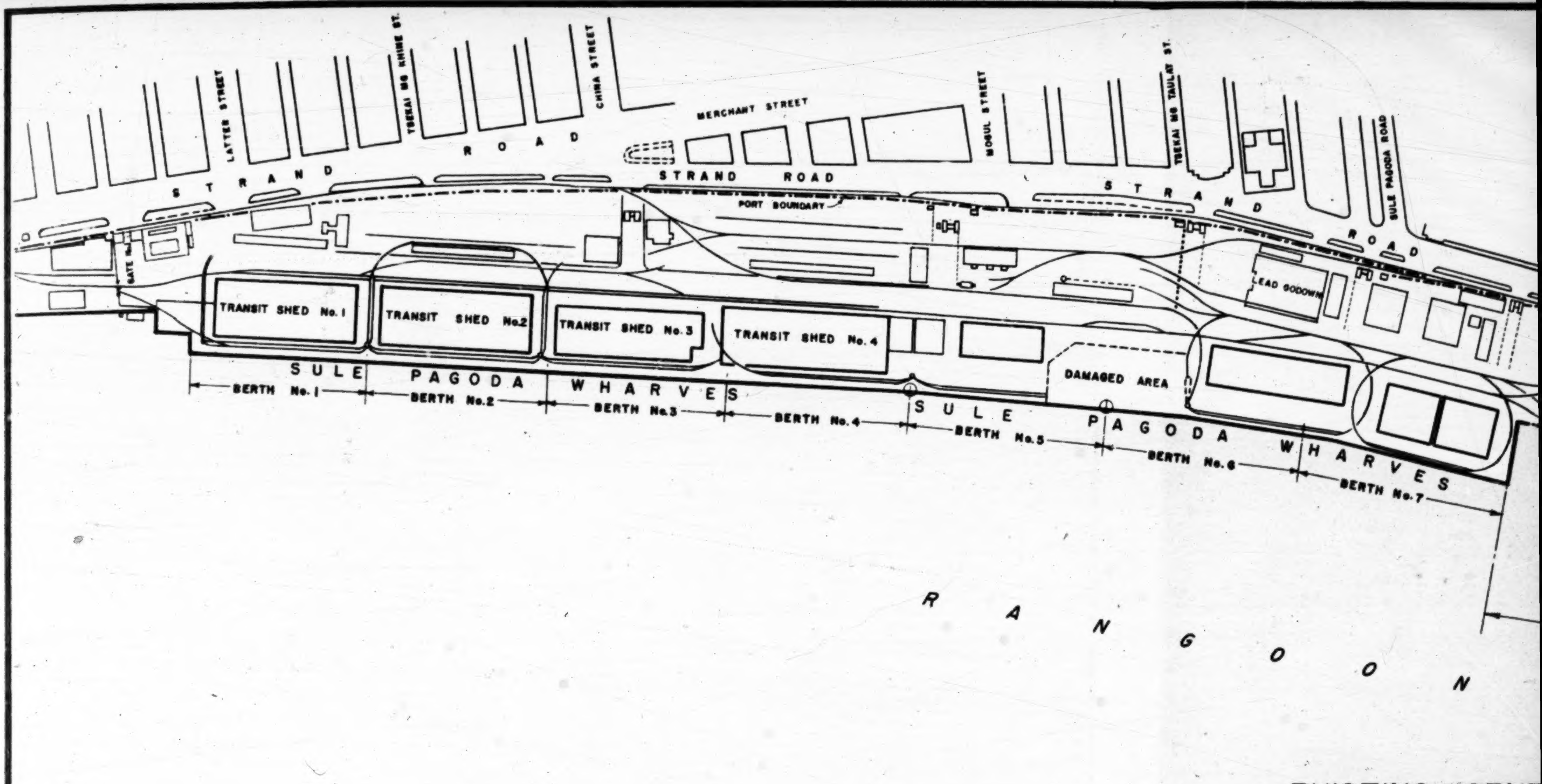
PORT OF RANGOON

SUGGESTED RECONSTRUCTION

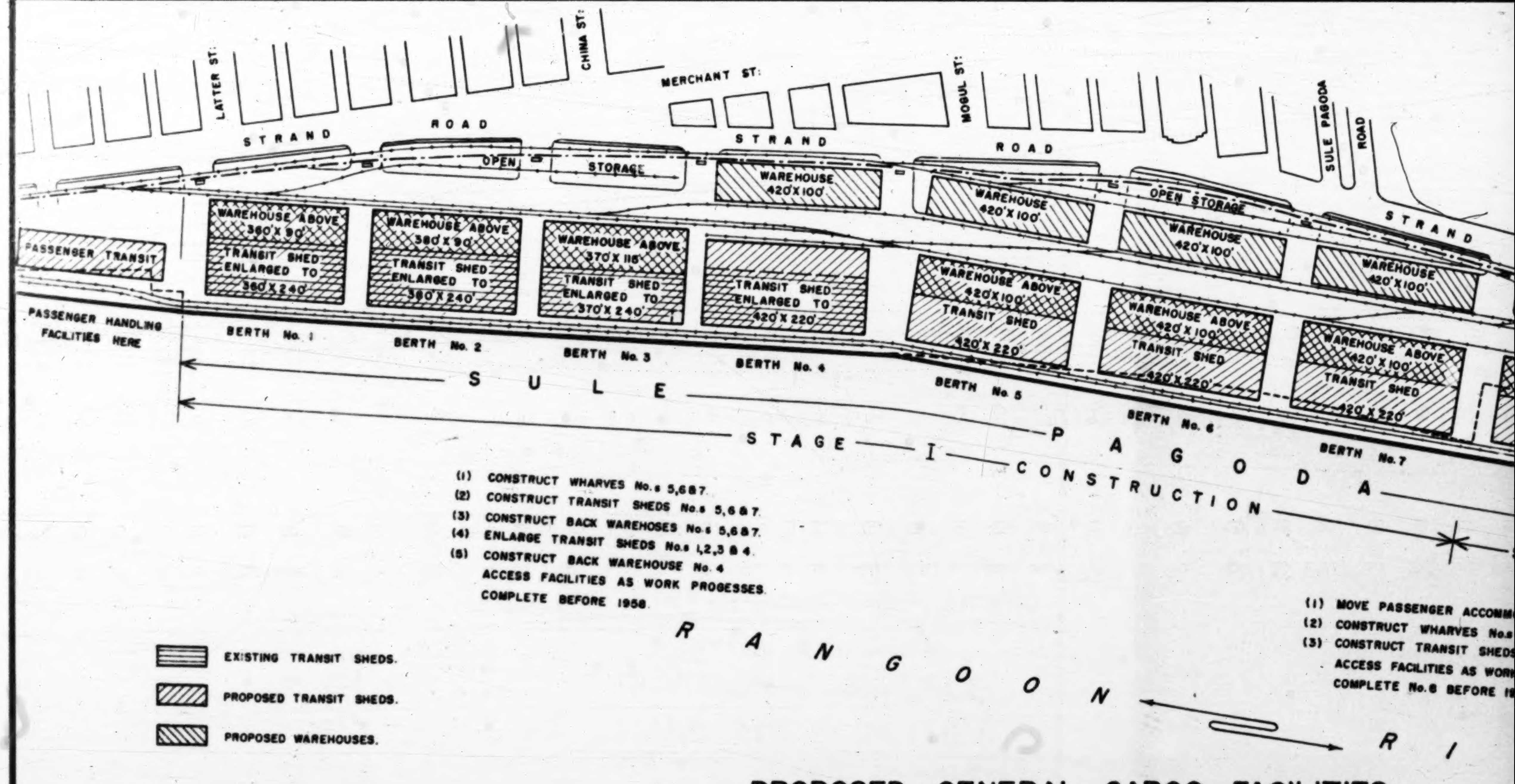
BOTATAUNG FORESHORE

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON

DR. BY. H.R.N DATE PLATE
CK. BY. EJP JUNE 53. NO. 4


LATTER STREET
TSEKAI MG KHINE ST.
CHINA STREET
MERCHANT STREET
MOGUL STREET
TSEKAI MG TAULAY ST.
SULE PAGODA ROAD
STRAND ROAD
STRAND ROAD
STRAND ROAD
PORT BOUNDARY
GATE
LEAD GODOWN
TRANSIT SHED No. 1
TRANSIT SHED No. 2
TRANSIT SHED No. 3
TRANSIT SHED No. 4
DAMAGED AREA
SULE PAGODA WHARVES
BERTH No. 1
BERTH No. 2
BERTH No. 3
BERTH No. 4
SULE PAGODA WHARVES
BERTH No. 5
BERTH No. 6
BERTH No. 7
RANGOON

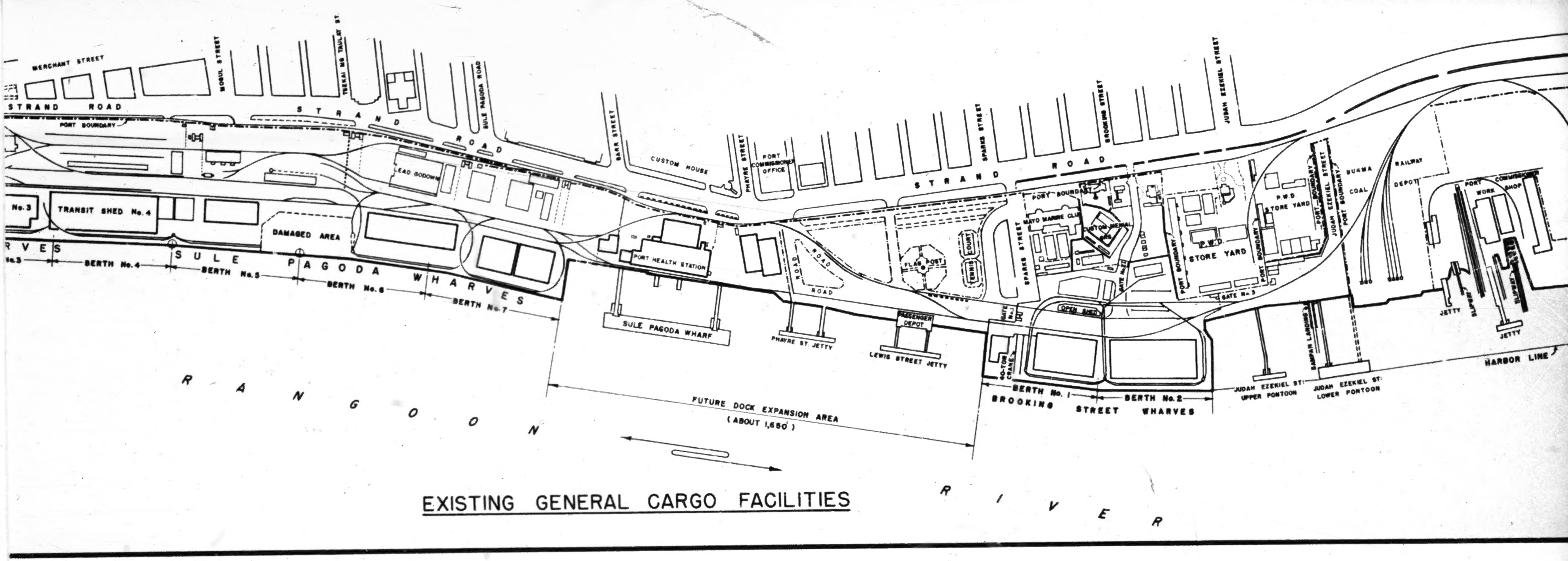
EXISTING GENE


LATTER ST:
CHINA ST:
MERCHANT ST:
MOGUL ST:
SULE PAGODA ROAD
STRAND ROAD
STRAND ROAD
STRAND
OPEN STORAGE
OPEN STORAGE
WAREHOUSE 420'X100'
WAREHOUSE 420'X100'
WAREHOUSE 420'X100'
WAREHOUSE 420'X100'
PASSENGER TRANSIT
PASSENGER HANDLING FACILITIES HERE
WAREHOUSE ABOVE 360'X90'
TRANSIT SHED ENLARGED TO 360'X240'
WAREHOUSE ABOVE 380'X90'
TRANSIT SHED ENLARGED TO 380'X240'
WAREHOUSE ABOVE 370'X115'
TRANSIT SHED ENLARGED TO 370'X240'
TRANSIT SHED ENLARGED TO 420'X220'
WAREHOUSE ABOVE 420'X100'
TRANSIT SHED 420'X220'
WAREHOUSE ABOVE 420'X100'
TRANSIT SHED 420'X220'
WAREHOUSE ABOVE 420'X100'
TRANSIT SHED 420'X220'
BERTH No. 1
BERTH No. 2
BERTH No. 3
BERTH No. 4
BERTH No. 5
BERTH No. 6
BERTH No. 7
SULE PAGODA
STAGE I CONSTRUCTION
RANGOON RI
▤ EXISTING TRANSIT SHEDS.
▨ PROPOSED TRANSIT SHEDS.
▧ PROPOSED WAREHOUSES.

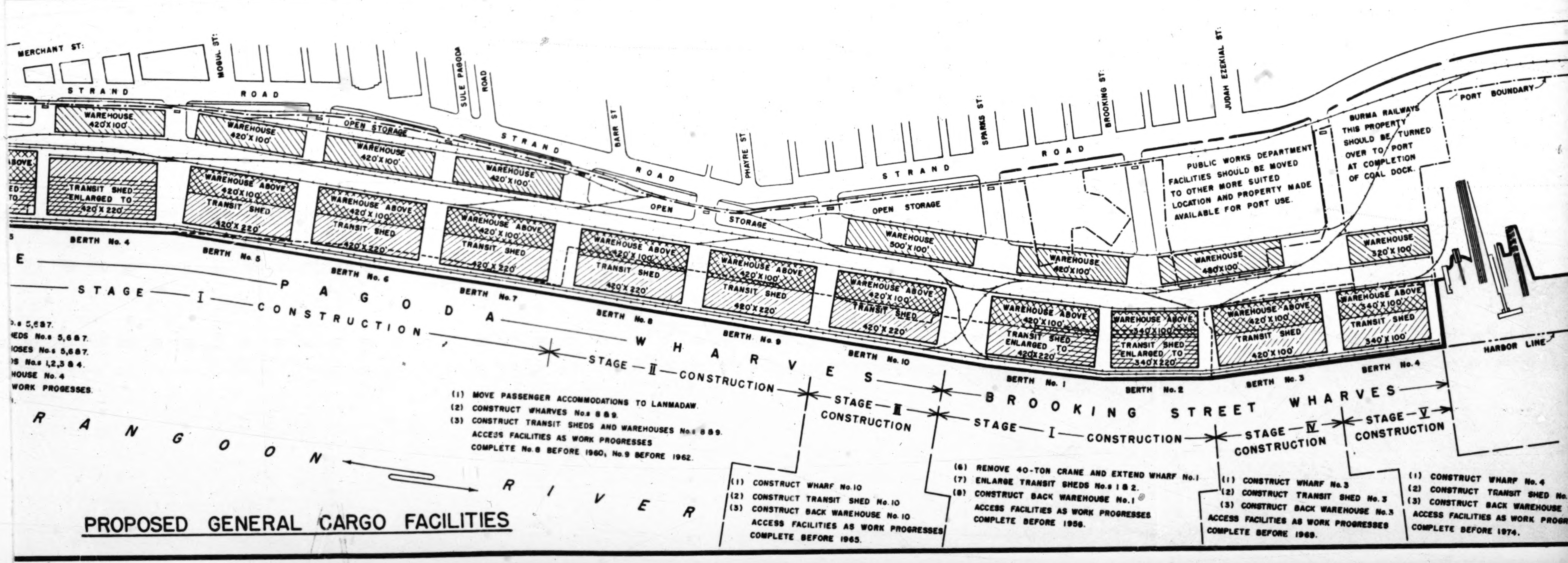
(1) CONSTRUCT WHARVES No.s 5,6&7.
(2) CONSTRUCT TRANSIT SHEDS No.s 5,6&7.
(3) CONSTRUCT BACK WAREHOSES No.s 5,6&7.
(4) ENLARGE TRANSIT SHEDS No.s 1,2,3 & 4.
(5) CONSTRUCT BACK WAREHOUSE No. 4
ACCESS FACILITIES AS WORK PROGESSES.
COMPLETE BEFORE 1956.

(1) MOVE PASSENGER ACCOMM
(2) CONSTRUCT WHARVES No.s
(3) CONSTRUCT TRANSIT SHEDS
ACCESS FACILITIES AS WORK
COMPLETE No.6 BEFORE 1

PROPOSED GENERAL CARGO FACILITIES


MERCHANT STREET
STRAND ROAD
MOGUL STREET
TSEKAI MG TAULAY ST.
SULE PAGODA ROAD
BARR STREET
CUSTOM HOUSE
PHAYRE STREET
PORT COMMISSIONERS OFFICE
SPARKS STREET
BROOKING STREET
JUDAH EZEKIEL STREET
PORT BOUNDARY
LEAD GODOWN
No. 3
TRANSIT SHED No. 4
DAMAGED AREA
PORT HEALTH STATION
SULE PAGODA WHARF
PHAYRE ST. JETTY
PASSENGER DEPOT
LEWIS STREET JETTY
FLAG POST
LEWIS COURT
MAYO MARINE CLUB
CUSTOM HOUSE
OPEN SHED
P.W.D. STORE YARD
GATE No. 3
BURMA RAILWAY COAL DEPOT
PORT COMMISSIONERS WORK SHOP
JETTY
SLIPWAY
HARBOR LINE
40-TON CRANE
SAMPAN LANDING
BERTH No. 3
BERTH No. 4
BERTH No. 5
BERTH No. 6
BERTH No. 7
SULE PAGODA WHARVES
BERTH No. 1
BERTH No. 2
BROOKING STREET WHARVES
JUDAH EZEKIEL ST: UPPER PONTOON
JUDAH EZEKIEL ST: LOWER PONTOON
FUTURE DOCK EXPANSION AREA (ABOUT 1,650')
RANGOON RIVER

EXISTING GENERAL CARGO FACILITIES


MERCHANT ST:
STRAND ROAD
MOGUL ST:
SULE PAGODA ROAD
BARR ST
PHAYRE ST
SPARKS ST:
BROOKING ST:
JUDAH EZEKIAL ST:
PORT BOUNDARY
WAREHOUSE 420'X100'
OPEN STORAGE
TRANSIT SHED ENLARGED TO 420'X 220'
WAREHOUSE ABOVE 420'X100'
TRANSIT SHED 420'X 220'
OPEN STORAGE
WAREHOUSE 500'X100'
WAREHOUSE 420'X100'
WAREHOUSE 480'X100'
WAREHOUSE 320'X100'
TRANSIT SHED ENLARGED TO 420'X220'
WAREHOUSE ABOVE 340'X100'
TRANSIT SHED ENLARGED TO 340'X220'
TRANSIT SHED 420'X100'
TRANSIT SHED 340'X100'
BERTH No. 4
BERTH No. 5
BERTH No. 6
BERTH No. 7
BERTH No. 8
BERTH No. 9
BERTH No. 10
SULE PAGODA WHARVES
BERTH No. 1
BERTH No. 2
BERTH No. 3
BERTH No. 4
BROOKING STREET WHARVES
HARBOR LINE
STAGE — I — CONSTRUCTION
STAGE — II — CONSTRUCTION
STAGE — III — CONSTRUCTION
STAGE — I — CONSTRUCTION
STAGE — IV — CONSTRUCTION
STAGE — V — CONSTRUCTION
RANGOON RIVER

PUBLIC WORKS DEPARTMENT FACILITIES SHOULD BE MOVED TO OTHER MORE SUITED LOCATION AND PROPERTY MADE AVAILABLE FOR PORT USE.

BURMA RAILWAYS THIS PROPERTY SHOULD BE TURNED OVER TO PORT AT COMPLETION OF COAL DOCK.

o.s 5,6&7.
HEDS No.s 5,6&7.
IOSES No.s 5,6&7.
OS No.s 1,2,3 & 4.
HOUSE No. 4
WORK PROGESSES.

(1) MOVE PASSENGER ACCOMMODATIONS TO LANMADAW.
(2) CONSTRUCT WHARVES No.s 8 & 9.
(3) CONSTRUCT TRANSIT SHEDS AND WAREHOUSES No.s 8 & 9.
ACCESS FACILITIES AS WORK PROGRESSES
COMPLETE No. 8 BEFORE 1960, No. 9 BEFORE 1962.

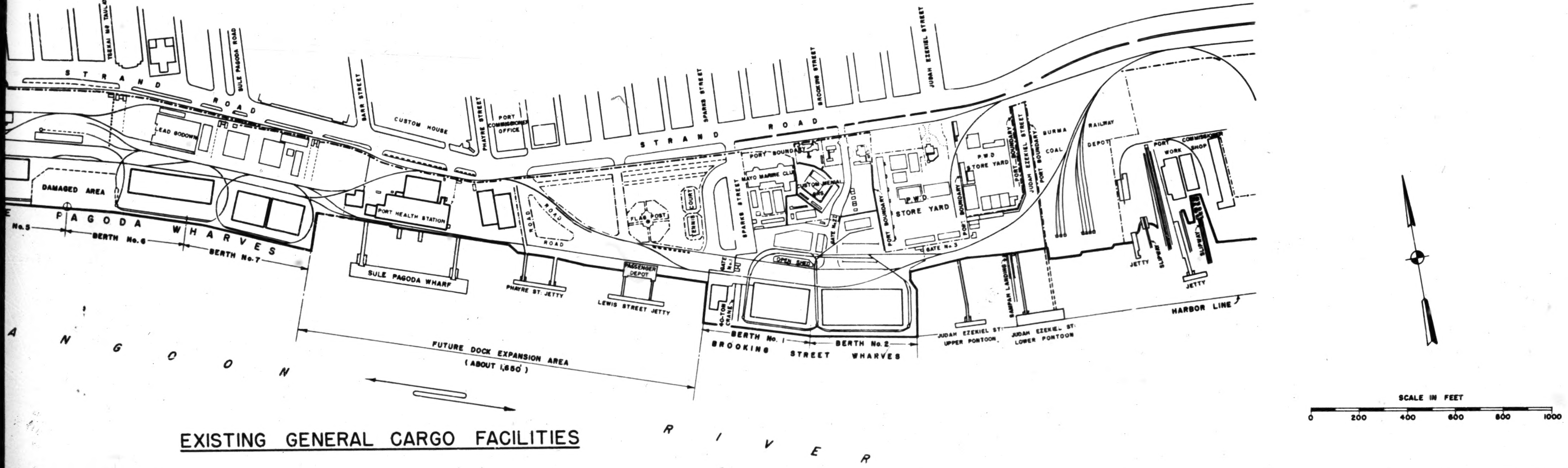
(1) CONSTRUCT WHARF No. 10
(2) CONSTRUCT TRANSIT SHED No. 10
(3) CONSTRUCT BACK WAREHOUSE No. 10
ACCESS FACILITIES AS WORK PROGRESSES
COMPLETE BEFORE 1965.

(6) REMOVE 40-TON CRANE AND EXTEND WHARF No. 1
(7) ENLARGE TRANSIT SHEDS No.s 1 & 2.
(8) CONSTRUCT BACK WAREHOUSE No. 1
ACCESS FACILITIES AS WORK PROGRESSES
COMPLETE BEFORE 1956.

(1) CONSTRUCT WHARF No. 3
(2) CONSTRUCT TRANSIT SHED No. 3
(3) CONSTRUCT BACK WAREHOUSE No. 3
ACCESS FACILITIES AS WORK PROGRESSES
COMPLETE BEFORE 1969.

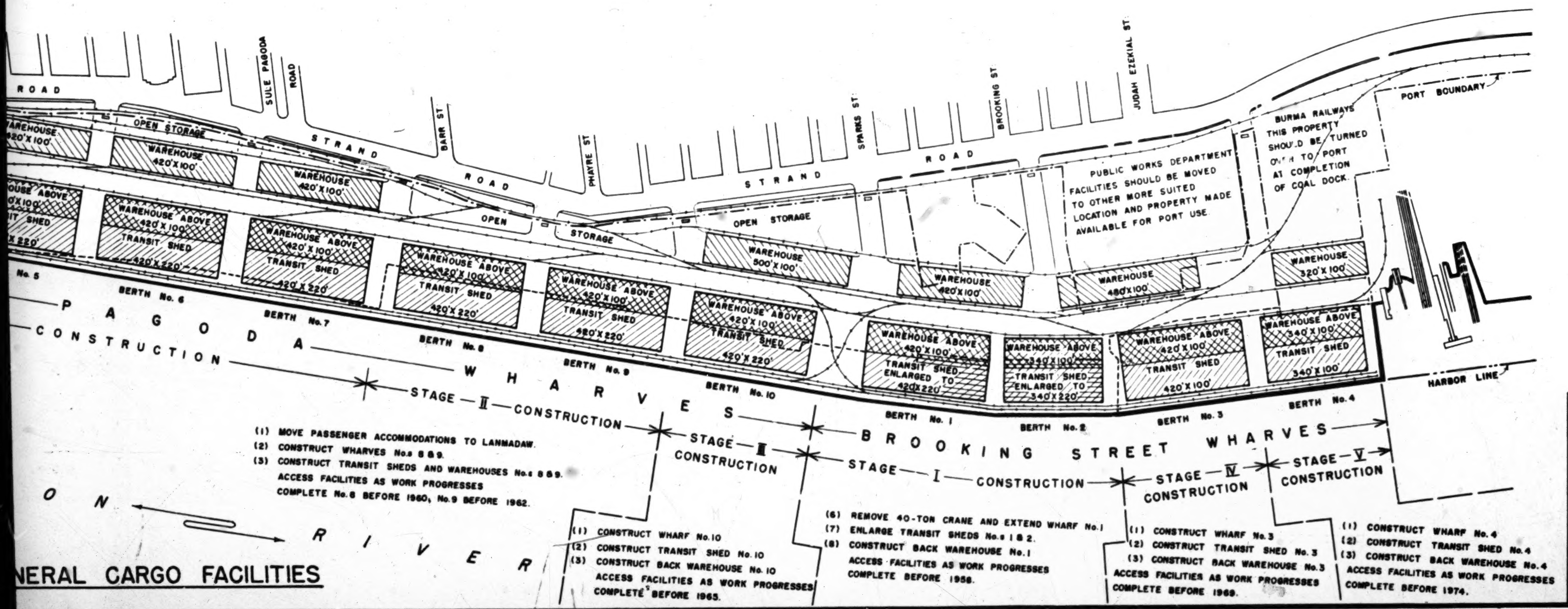
(1) CONSTRUCT WHARF No. 4
(2) CONSTRUCT TRANSIT SHED No.
(3) CONSTRUCT BACK WAREHOUSE
ACCESS FACILITIES AS WORK PROGR
COMPLETE BEFORE 1974.

PROPOSED GENERAL CARGO FACILITIES



TREKAI MB TAULAY ST
SULE PAGODA ROAD
STRAND ROAD
LEAD GODOWN
DAMAGED AREA
No. 5
BERTH No. 6
BERTH No. 7
PAGODA WHARVES
BARR STREET
CUSTOM HOUSE
PHAYRE STREET
PORT COMMISSIONERS OFFICE
PORT HEALTH STATION
SULE PAGODA WHARF
PHAYRE ST. JETTY
ROAD
PASSENGER DEPOT
LEWIS STREET JETTY
FLAG POST
TENNIS COURT
SPARKS STREET
PORT BOUNDARY
MAYO MARINE CLUB
CUSTOM MENAL
GATE No. 1
GATE No. 2
GATE No. 3
OPEN SHED
40-TON CRANE
BROOKING STREET
JUDAH EZEKIEL STREET
P.W.D. STORE YARD
PWD STORE YARD
BURMA RAILWAY
COAL DEPOT
PORT COMMISSIONERS WORK SHOP
JETTY
SLIPWAY
SAMPAN LANDING
JUDAH EZEKIEL ST. UPPER PONTOON
JUDAH EZEKIEL ST. LOWER PONTOON
HARBOR LINE
BERTH No. 1
BERTH No. 2
BROOKING STREET WHARVES
FUTURE DOCK EXPANSION AREA (ABOUT 1,650')
RANGOON RIVER
SCALE IN FEET
0 200 400 600 800 1000

EXISTING GENERAL CARGO FACILITIES



ROAD
SULE PAGODA ROAD
BARR ST
PHAYRE ST
SPARKS ST
BROOKING ST
JUDAH EZEKIAL ST
STRAND ROAD
OPEN STORAGE
WAREHOUSE 420'X100'
WAREHOUSE ABOVE 420'X100'
TRANSIT SHED 420'X220'
OPEN STORAGE
WAREHOUSE 500'X100'
WAREHOUSE 420'X100'
WAREHOUSE 480'X100'
WAREHOUSE 320'X100'
TRANSIT SHED ENLARGED TO 420'X220'
WAREHOUSE ABOVE 340'X100'
TRANSIT SHED ENLARGED TO 340'X220'
WAREHOUSE ABOVE 420'X100'
TRANSIT SHED 420'X100'
WAREHOUSE ABOVE 340'X100'
TRANSIT SHED 340'X100'
PUBLIC WORKS DEPARTMENT FACILITIES SHOULD BE MOVED TO OTHER MORE SUITED LOCATION AND PROPERTY MADE AVAILABLE FOR PORT USE.
BURMA RAILWAYS THIS PROPERTY SHOULD BE TURNED OVER TO PORT AT COMPLETION OF COAL DOCK.
PORT BOUNDARY
HARBOR LINE
No. 5
BERTH No. 6
BERTH No. 7
BERTH No. 8
BERTH No. 9
BERTH No. 10
BERTH No. 1
BERTH No. 2
BERTH No. 3
BERTH No. 4
PAGODA WHARVES
BROOKING STREET WHARVES
CONSTRUCTION
STAGE — II — CONSTRUCTION
STAGE — III — CONSTRUCTION
STAGE — I — CONSTRUCTION
STAGE — IV — CONSTRUCTION
STAGE — V — CONSTRUCTION
RIVER
SCALE IN FEET
0 200 400 600 800 1000

(1) MOVE PASSENGER ACCOMMODATIONS TO LANMADAW.
(2) CONSTRUCT WHARVES No.s 8 & 9.
(3) CONSTRUCT TRANSIT SHEDS AND WAREHOUSES No.s 8 & 9.
ACCESS FACILITIES AS WORK PROGRESSES
COMPLETE No. 8 BEFORE 1960, No. 9 BEFORE 1962.

(1) CONSTRUCT WHARF No. 10
(2) CONSTRUCT TRANSIT SHED No. 10
(3) CONSTRUCT BACK WAREHOUSE No. 10
ACCESS FACILITIES AS WORK PROGRESSES
COMPLETE BEFORE 1965.

(6) REMOVE 40-TON CRANE AND EXTEND WHARF No. 1
(7) ENLARGE TRANSIT SHEDS No.s 1 & 2.
(8) CONSTRUCT BACK WAREHOUSE No. 1
ACCESS FACILITIES AS WORK PROGRESSES
COMPLETE BEFORE 1958.

(1) CONSTRUCT WHARF No. 3
(2) CONSTRUCT TRANSIT SHED No. 3
(3) CONSTRUCT BACK WAREHOUSE No. 3
ACCESS FACILITIES AS WORK PROGRESSES
COMPLETE BEFORE 1969.

(1) CONSTRUCT WHARF No. 4
(2) CONSTRUCT TRANSIT SHED No. 4
(3) CONSTRUCT BACK WAREHOUSE No. 4
ACCESS FACILITIES AS WORK PROGRESSES
COMPLETE BEFORE 1974.

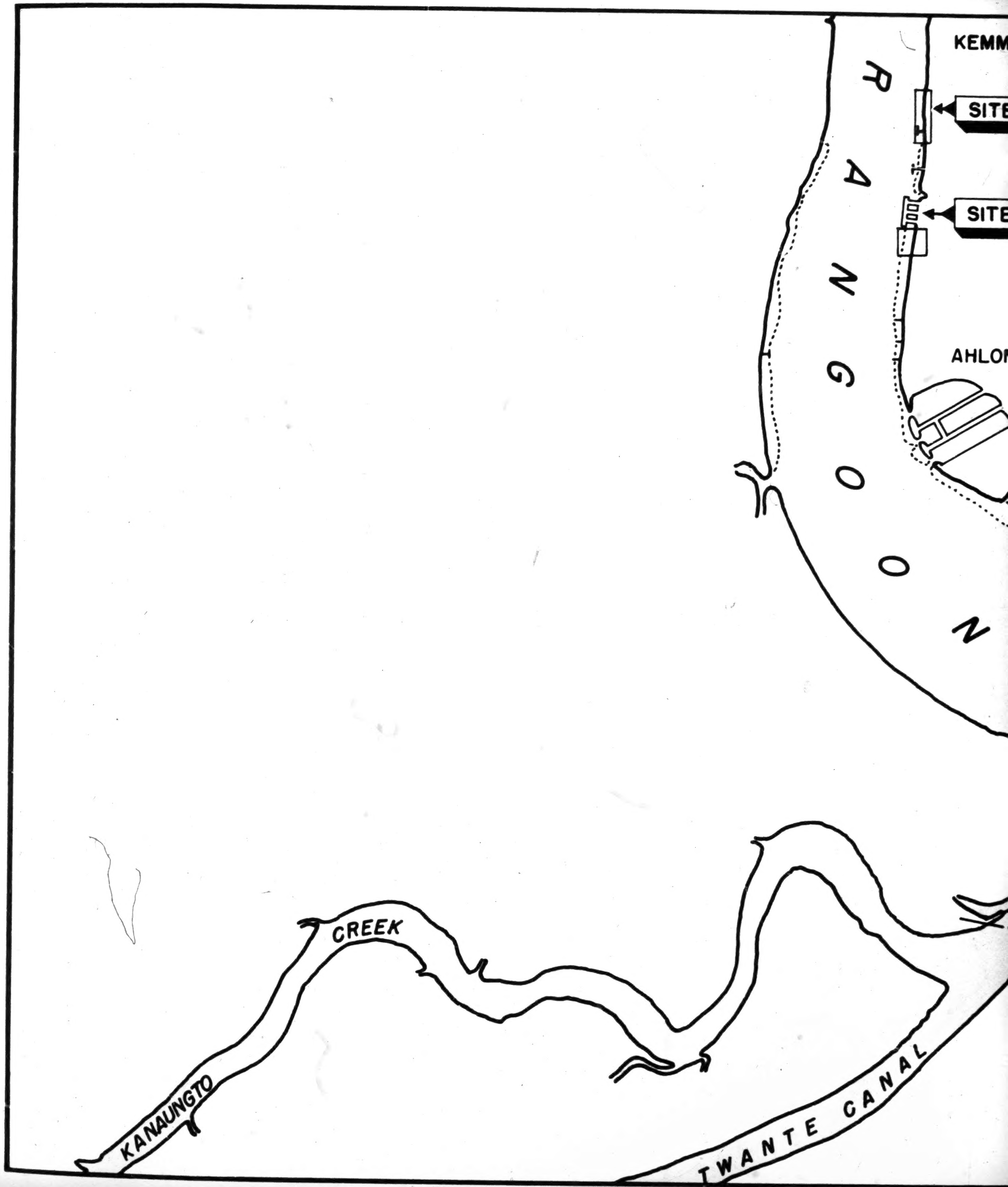
NERAL CARGO FACILITIES

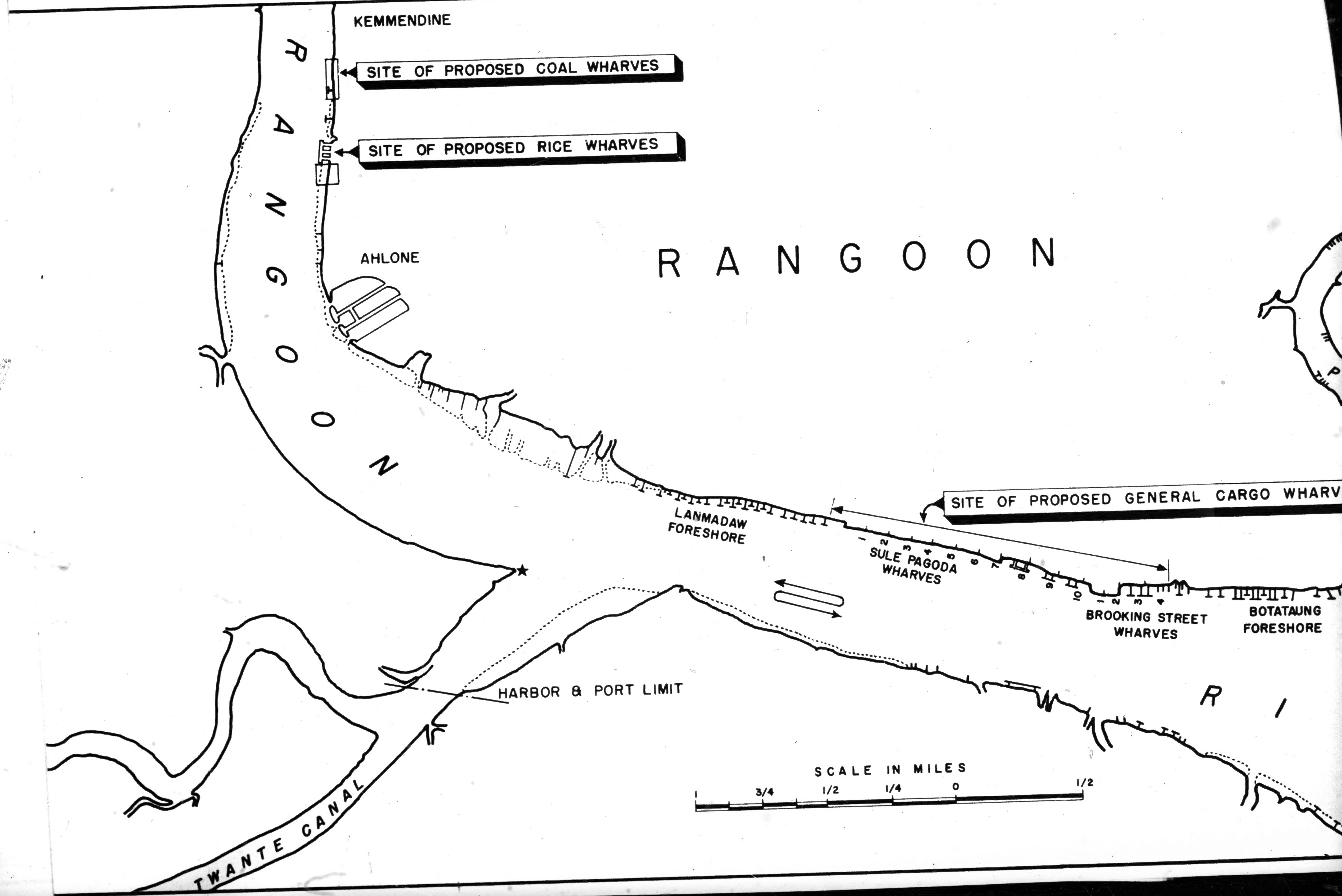
MINISTRY OF NATIONAL PLANNING

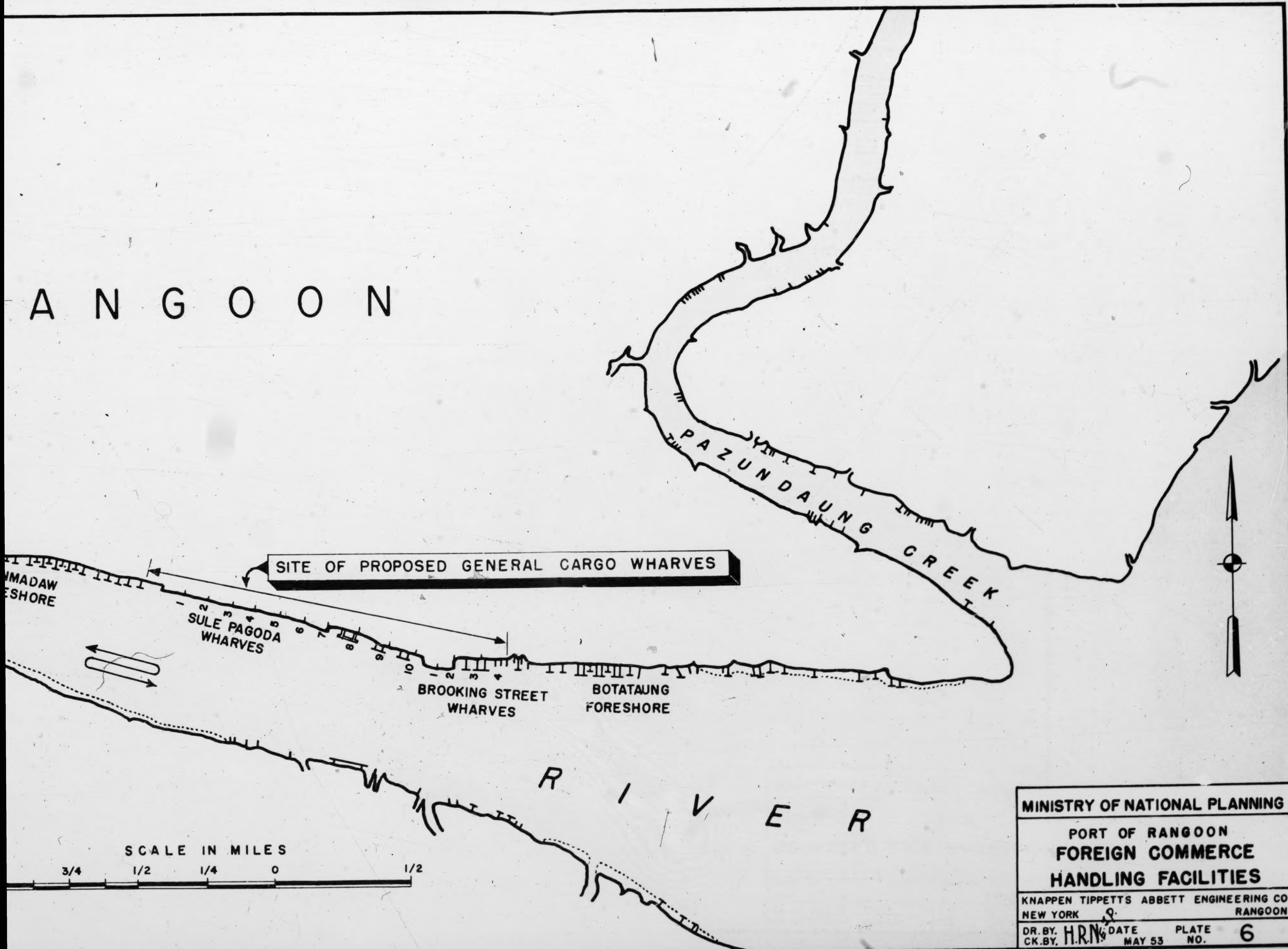
PORT OF RANGOON
PROPOSED
GENERAL CARGO WHARVES

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON.

DR. BY: HRN. E.J.P. DATE MAY 1953 PLATE NO. 5
CK. BY: HRN.


KEMM
SITE
SITE
AHLON
RANGOON
KANAUNGTO CREEK
TWANTE CANAL


KEMMENDINE
SITE OF PROPOSED COAL WHARVES
SITE OF PROPOSED RICE WHARVES
RANGOON
AHLONE
RANGOON
P
SITE OF PROPOSED GENERAL CARGO WHARV
LANMADAW FORESHORE
1 2 3 4 5 6 7 8 9 10
SULE PAGODA WHARVES
1 2 3 4
BROOKING STREET WHARVES
BOTATAUNG FORESHORE
HARBOR & PORT LIMIT
R I
TWANTE CANAL
SCALE IN MILES
1 3/4 1/2 1/4 0 1/2

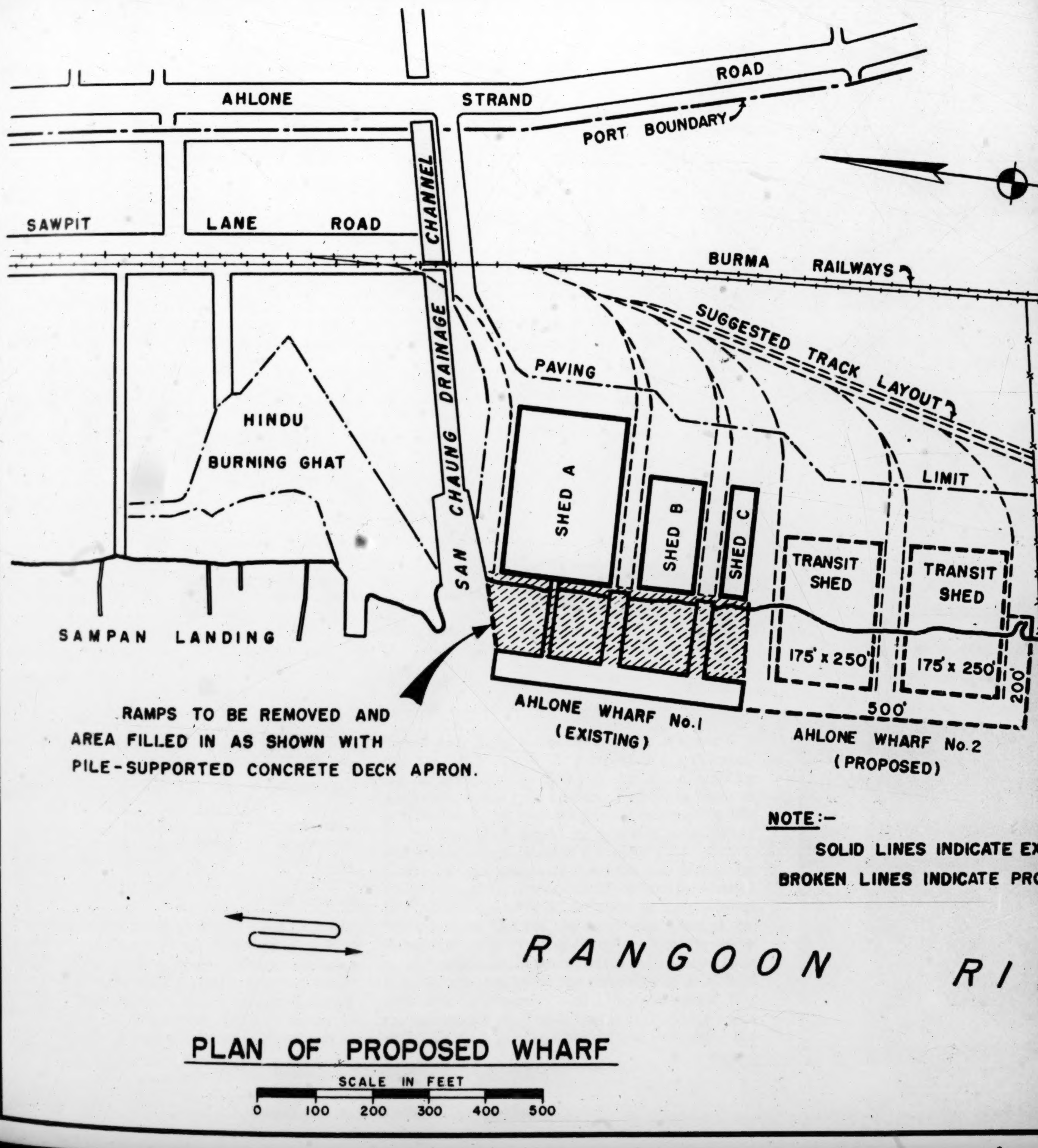

ANGOON
PAZUNDAUNG CREEK
SITE OF PROPOSED GENERAL CARGO WHARVES
NMADAW
ESHORE
1
2
3
4
5
6
7
8
9
10
SULE PAGODA
WHARVES
1
2
3
4
BROOKING STREET
WHARVES
BOTATAUNG
FORESHORE
RIVER
SCALE IN MILES
3/4
1/2
1/4
0
1/2

MINISTRY OF NATIONAL PLANNING

PORT OF RANGOON
FOREIGN COMMERCE
HANDLING FACILITIES

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. H.R.N.
CK. BY.
DATE MAY 53
PLATE NO. 6


AHLONE
STRAND
ROAD
PORT BOUNDARY
SAWPIT
LANE
ROAD
SAN CHAUNG DRAINAGE CHANNEL
BURMA RAILWAYS
SUGGESTED TRACK LAYOUT
PAVING
LIMIT
HINDU
BURNING GHAT
SHED A
SHED B
SHED C
TRANSIT SHED
175' x 250'
TRANSIT SHED
175' x 250'
200'
500'
SAMPAN LANDING
AHLONE WHARF No. 1
(EXISTING)
AHLONE WHARF No. 2
(PROPOSED)
RANGOON RI
SCALE IN FEET
0
100
200
300
400
500

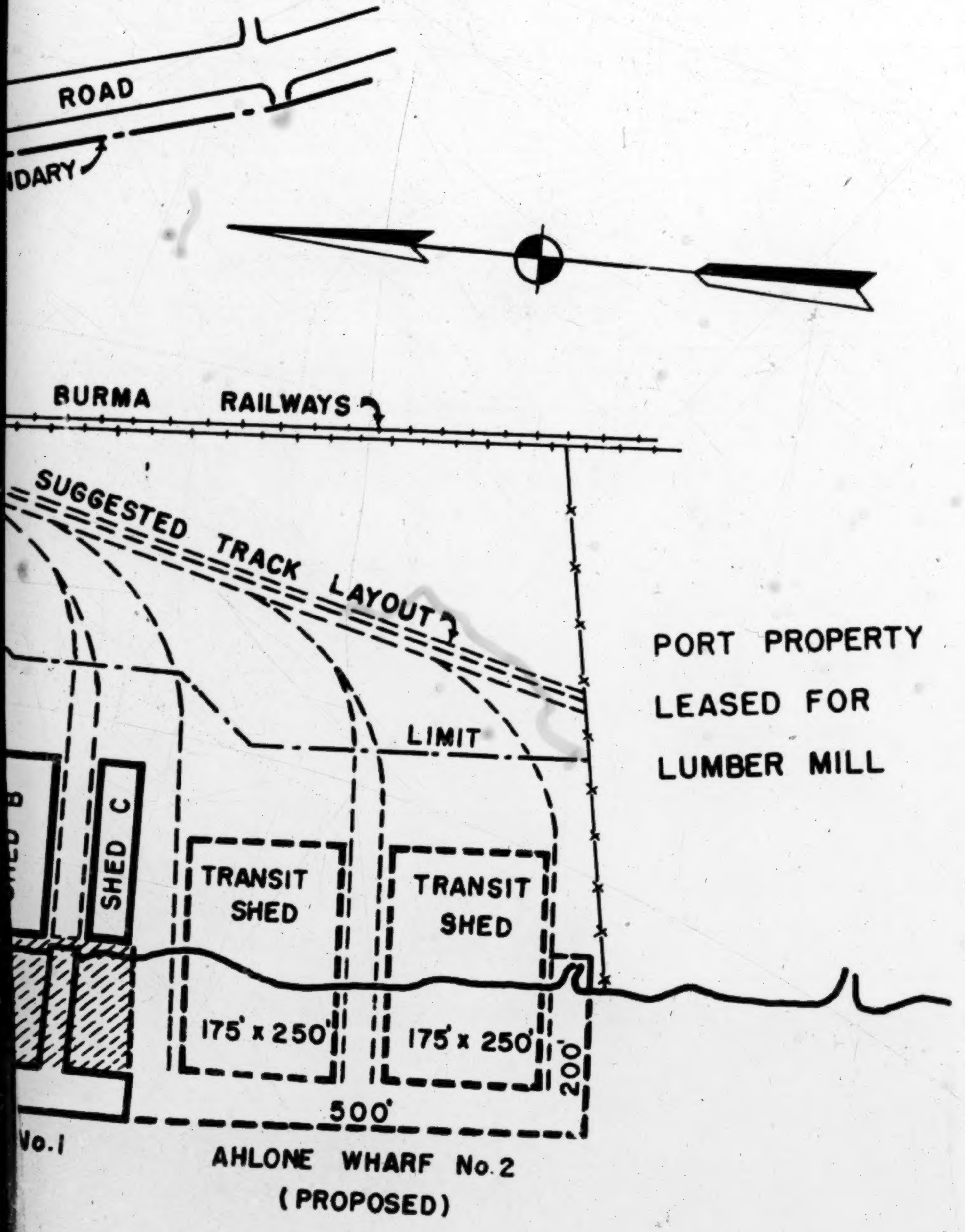
RAMPS TO BE REMOVED AND AREA FILLED IN AS SHOWN WITH PILE-SUPPORTED CONCRETE DECK APRON.

NOTE:-

SOLID LINES INDICATE EX

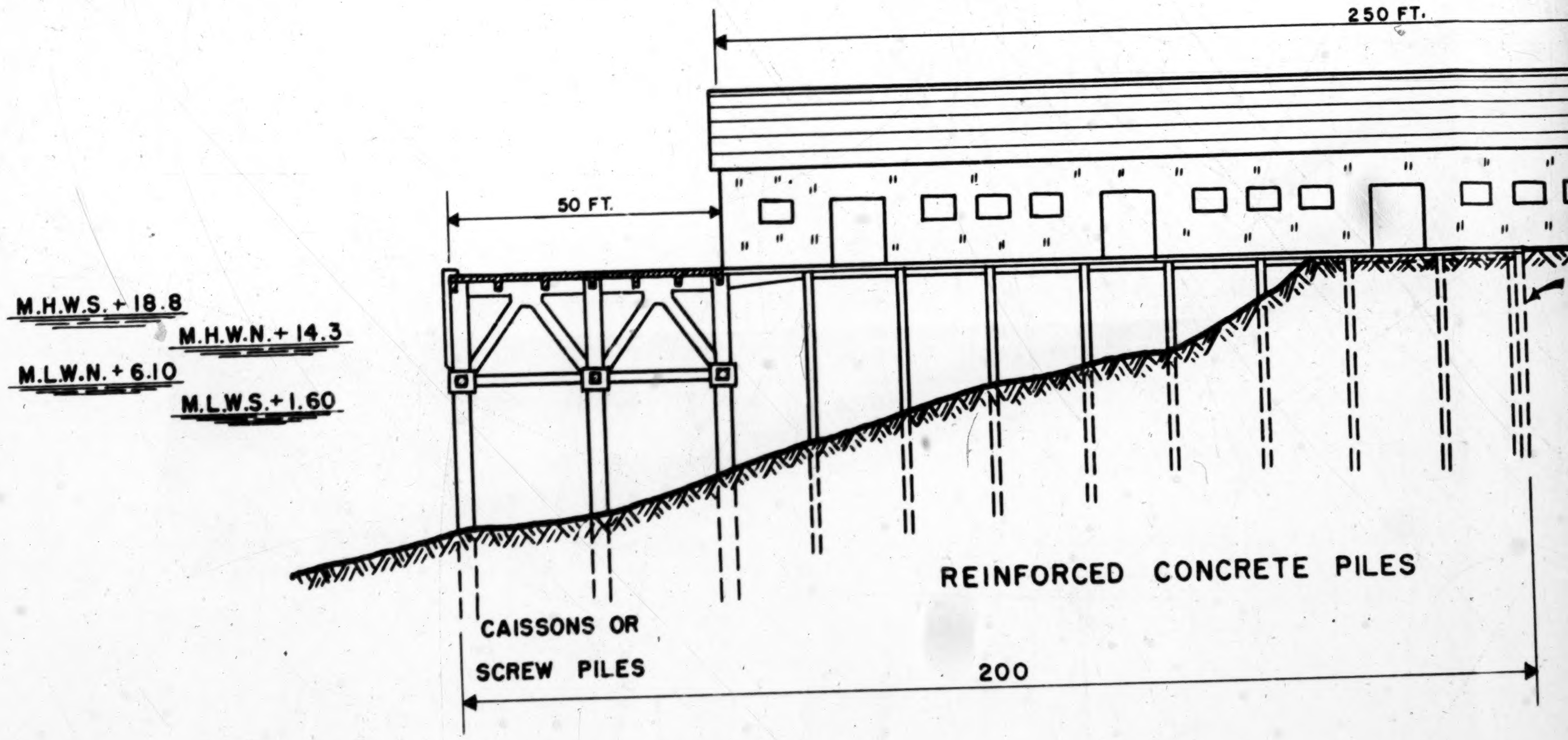
BROKEN LINES INDICATE PRO

PLAN OF PROPOSED WHARF


ROAD
NDARY
BURMA RAILWAYS
SUGGESTED TRACK LAYOUT
PORT PROPERTY
LEASED FOR
LUMBER MILL
LIMIT
SHED B
SHED C
TRANSIT SHED
175' x 250'
TRANSIT SHED
175' x 250'
200'
500'
No.1
AHLONE WHARF No. 2
(PROPOSED)
GOON RIVER

NOTE:-

SOLID LINES INDICATE EXISTING STRUCTURES.
BROKEN LINES INDICATE PROPOSED WORK.


250 FT.
50 FT.
M.H.W.S. + 18.8
M.H.W.N. + 14.3
M.L.W.N. + 6.10
M.L.W.S. + 1.60
REINFORCED CONCRETE PILES
CAISSONS OR
SCREW PILES
200

SECTION THROUGH PROPOSED WH

SCALE IN FEET

0 20 40 60 80 100

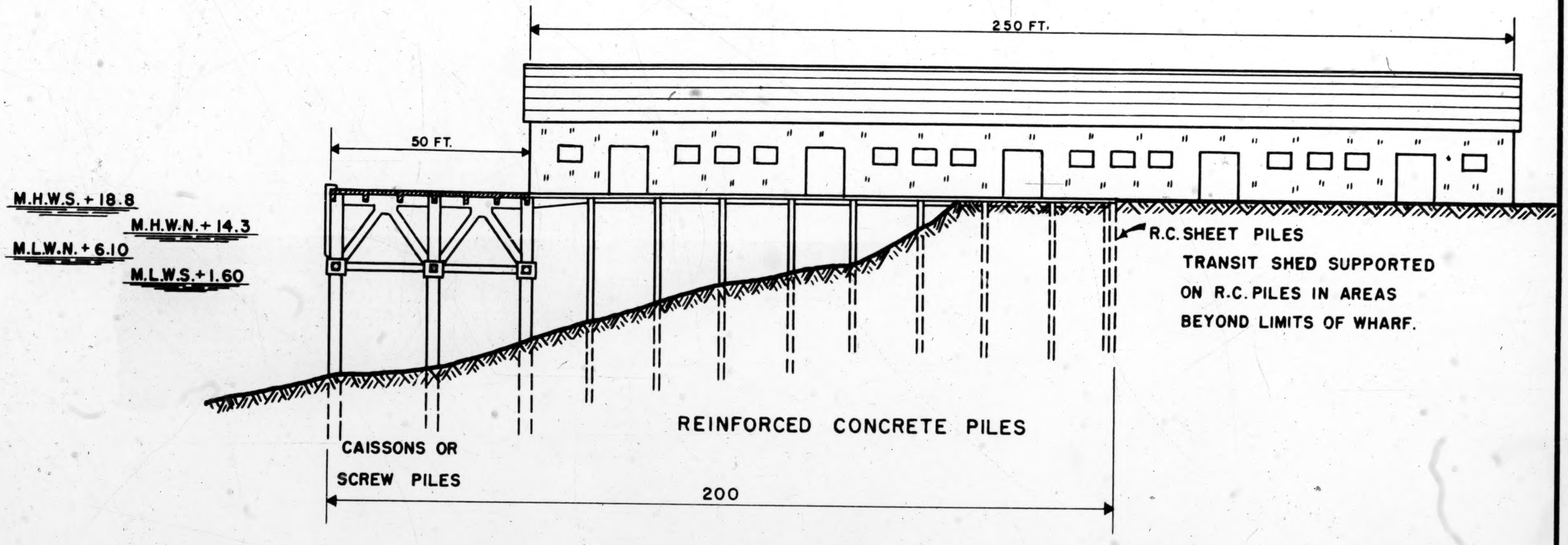
NOTE:-

TYPICAL SECTION USED FOR COSTING ONLY, NOT BASED ON DETAILED DESIGN AS REQUIRED FOR CONSTRUCTION.

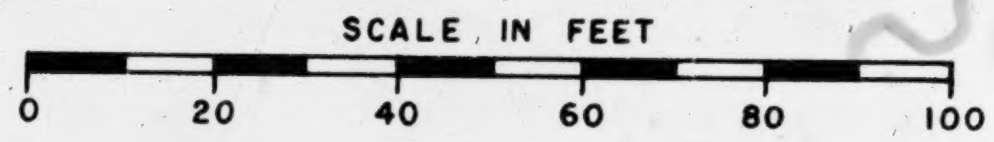
RT PROPERTY
ASED FOR
MBER MILL

STRUCTURES.
WORK.

R


250 FT.
50 FT.
M.H.W.S. + 18.8
M.H.W.N. + 14.3
M.L.W.N. + 6.10
M.L.W.S. + 1.60
R.C. SHEET PILES
TRANSIT SHED SUPPORTED ON R.C. PILES IN AREAS BEYOND LIMITS OF WHARF.
REINFORCED CONCRETE PILES
CAISSONS OR SCREW PILES
200

SECTION THROUGH PROPOSED WHARF


SCALE IN FEET
0
20
40
60
80
100

NOTE :–

TYPICAL SECTION USED FOR COSTING ONLY, NOT BASED ON DETAILED DESIGN AS REQUIRED FOR CONSTRUCTION.

MINISTRY OF NATIONAL PLANNING

PORT OF RANGOON

PROPOSED RICE WHARVES

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY H.R.N.
CK. BY H.R.N.
DATE MAY 53
PLATE NO. 7

TABLE XII – 4A

EXPORT AND IMPORT TONNAGES OF PRINCIPAL COMMODITIES IN THE PORT OF RANGOON

(thousands of tons)

	Prewar 1940–41	*1947–48*	*1948–49*	*1949–50*	*1950–51*	*1951–52*
Exports						
Petroleum, Oil and Lubricants	774·1	16·4	17·4	15·8	18·6	21·3
Rice and Rice Products	2,192·0	903·0	777·4	730·7	1,018·1	840·7
Timber	192·9	96·0	54·1	8·8	56·2	59·2
Minerals	72·2	7·0	9·7	0·8	17·4	22·2
Others	317·1	191·7	111·3	101·2	150·5	197·5
Sub-Total	3,552·9	1,214·1	969·9	857·3	1,260·8	1,140·9
Imports						
Coal	326·7	173·7	84·9	102·1	124·6	164·4
Petroleum, Oil and Lubricants	86·0	185·0	137·2	123·6	113·2	124·1
Salt	23·1	24·0	40·0	18·5	20·9	15·9
General Merchandise	958·3	440·9	251·2	288·6	392·1	463·8
Sub-Total	1,394·1	823·6	513·3	532·8	650·8	768·2
Total Volume of Traffic	4,947·0	2,037·7	1,483·2	1,390·1	1,911·6	1,909·1

TABLE XII – 5

RIVER-BORNE TRADE IN THE PORT OF RANGOON

(tons)

	1946–47	*1947–48*	*1948–49*	*1949–50*	*1950–51*	*1951–52*
Landed	275,773	301,894	244,166	448,839	479,650	497,784
Shipped	86,496	98,979	81,322	136,715	144,181	156,475
Total	362,269	400,873	305,488	585,554	622,831	654,259

hatch per hour. The following commodities were handled over the wharves in fiscal year 1951–52:

Imported General Cargo	463,800 tons
Exported General Cargo (about 60% of 197,500 tons)	118,500 tons
Exported Minerals	22,200 tons
Imported Salt	15,900 tons
	620,400 tons

Although the rate of handling of export minerals may be lower than the average handling rate of general cargo, the former does not materially affect the latter as the tonnage of minerals is equal to less than 4% of the general-cargo tonnage. At the average handling rate of 450 tons per ship per day and with six berths in operation, the average number of working days in fiscal year 1951–52 was about 230 days or about 77% of berth occupancy. At the present low rate of handling, it thus appears that the capacity of existing wharves is nearing the saturation point. In order to provide for the expected progressive increase of traffic the handling rate should be increased substantially and new wharfage facilities provided.

The charges on goods imported and landed on Commissioners' premises, or shipped from the wharves by Commissioners' labor, are listed in the published "Schedule of Charges, By-Laws and General Information" of the Port of Rangoon. The charge by weight up to a maximum of one ton per single package is K5.80 per ton, increasing progressively to K12.25 per ton for packages of over 15 tons in weight. The charges include the cost of transport from ship's side to transit shed, sorting, stacking and storage for the demurrage-free period. The stevedore's charges for import and export general cargo are about K2.00 per ton.

The following pertinent facts relative to the loading and unloading of imported general cargo may be summarized: stevedores and dock labor in their two regular shifts work a net of about 15 hours per day; however, in most cases the stevedore labor works after 10 p.m. to aggregate up to 21 hours per day. After the dock labor leaves at 10 p.m. cargo is unloaded into lighters instead of onto the wharf, and these lighters are unloaded by the dock labor the following morning, thus requiring that part of the cargo be handled twice.

The Commissioners' Traffic Department contemplates expanding the working period of the dock labor from 15 to 16 net hours per day and discontinuing the night loading of the lighters at the wharf. However, this measure alone will not materially improve the low cargo-handling rate. Stevedore companies now must hire their labor from the Dock Labor Board which started to function February 1, 1952, and the personnel in the gangs vary from day to day. Teamwork and efficiency of the gangs consequently are much less than when the companies could hire and organize labor into permanent gangs. In keeping with the policy of permitting only Burmese citizens to work, the prewar South Indian labor is being replaced with Burmans. Since Burmans are of smaller stature, it is admitted that the present and future labor force will be able to produce less work per man-hour. With part of the dock labor of the Commissioners' Traffic Department on a day-to-day pay basis less efficient labor is obtained.

The movement of cargo between ship and transit sheds is too slow to permit economic utilization of all the ship's gear. Consequently a low unit rate of handling is obtained. Damaged goods are held in lockfasts in the transit sheds until claims are settled, with consequent reduction of cargo-handling area. Customs are too slow in clearing cargo from the sheds with the cause ascribed to the volume of paperwork required and the inexperience of the clerks, and consignees taking too much time to remove their cargo; consequently a high demurrage factor is obtained. Although the demurrage-free time for undamaged cargo is 72 hours after the final discharge, demurrage charges collected indicate that time of storage averages seven to eight days. Storage for more than 72 hours in transit sheds should not be necessary.

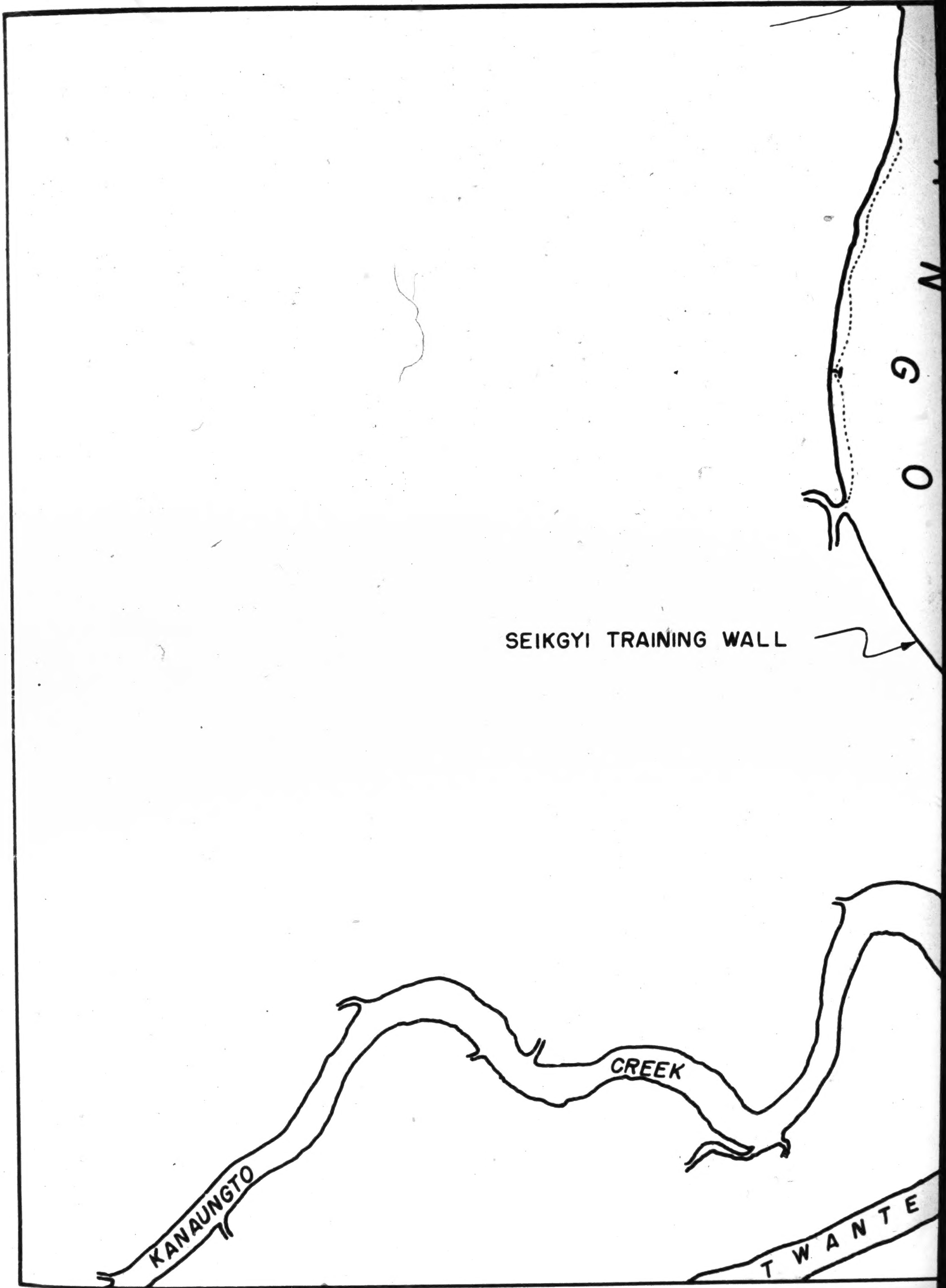
b. Exported General Cargo

This classification of commerce at present represents over 17% of the foreign trade. Principal export commodities, in order of magnitude of tonnage, are gram, beans and other pulses, oil cakes, maize, hides and skins, raw tobacco and others. The total tonnage was 317,000 tons in fiscal year 1940–41 or 9% of the total exports from Rangoon, with the corresponding figures for fiscal year 1951–52 of 197,500 tons and 17·3%. In fiscal year 1951–52, about 60% of exported general cargo was loaded from the wharves. The rate of handling was approximately equal to that for imported general cargo. The miscellaneous export cargo which is loaded from the lighters is shipped simultaneously with timber, rice and other products, but is only a fraction of the total tonnage of export cargo loaded on ships in midstream. Consequently, the rate of handling of miscellaneous export cargo could not materially affect the over-all rate of cargo handling in the Port.

c. Imported Coal

Before the war, the average normal import of coal was about 350,000 tons per year. Of this tonnage, the Burma Railways was the largest single consumer, using 180,000 tons a year. The balance was divided between the Irrawaddy Flotilla Company with over 100,000 tons, the Rangoon Electric Tramway and Supply Company and other industries. After the war, the consumption diminished considerably to about 102,000 tons in the fiscal year 1949–50, 125,000 tons in 1950–51 and 164,000 tons in 1951–52. During the calendar year 1952 the total import of coal was 204,388 tons, out of which 100,730 tons went to Burma Railways and 32,996 tons to R.E.T. & S. Co. The rate of coal imports in 1953 is scheduled at three ships per month, or about 220,000 tons per year. The procurement, shipping and distribution of coal in Rangoon is handled at present by the Coal and Coke Agency, organized at the request of the Government of the Union of Burma by five private trading companies. The Agency buys coal in Calcutta for and on behalf of the Government (arranging the financing also whenever necessary), ships in chartered vessels to Rangoon, unloads and distributes to consumers.

The coal is unloaded from ships moored in midstream into lighters of 50 to 150 tons capacity. The lighters are towed to shore and there unloaded at the storage yards of Burma Railways, of the Rangoon Electric Tramway and Supply Company, Ltd., and of the Coal and Coke Agency. The Burma Railway maintains two coal yards, one on the left bank of Rangoon River, east of Brooking Street Wharves, with an area of about 200,000 sq. ft. and seven railway sidings; and another with an area of about 100,000 sq. ft. and three railway sidings at the Commissioners' Rowett Estate on Pazundaung Creek. The storage yard of Coal and Coke Agency on the left bank of Rangoon River at Lansdown Street distributes to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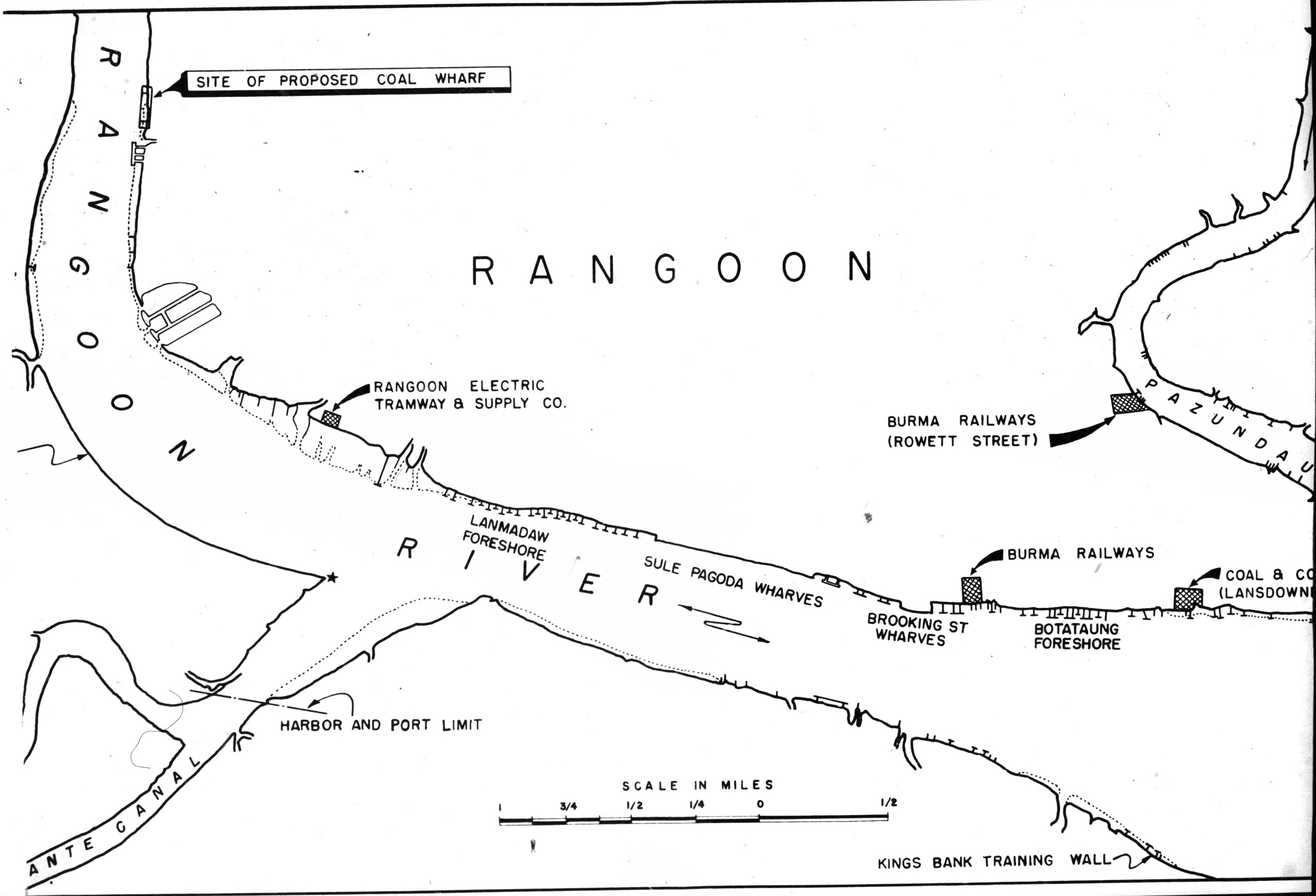
SITE OF PROPOSED COAL WHARF
RANGOON RIVER
RANGOON
RANGOON ELECTRIC TRAMWAY & SUPPLY CO.
BURMA RAILWAYS (ROWETT STREET)
PAZUNDAU
LANMADAW FORESHORE
SULE PAGODA WHARVES
BURMA RAILWAYS
COAL & CO
(LANSDOWN
BROOKING ST WHARVES
BOTATAUNG FORESHORE
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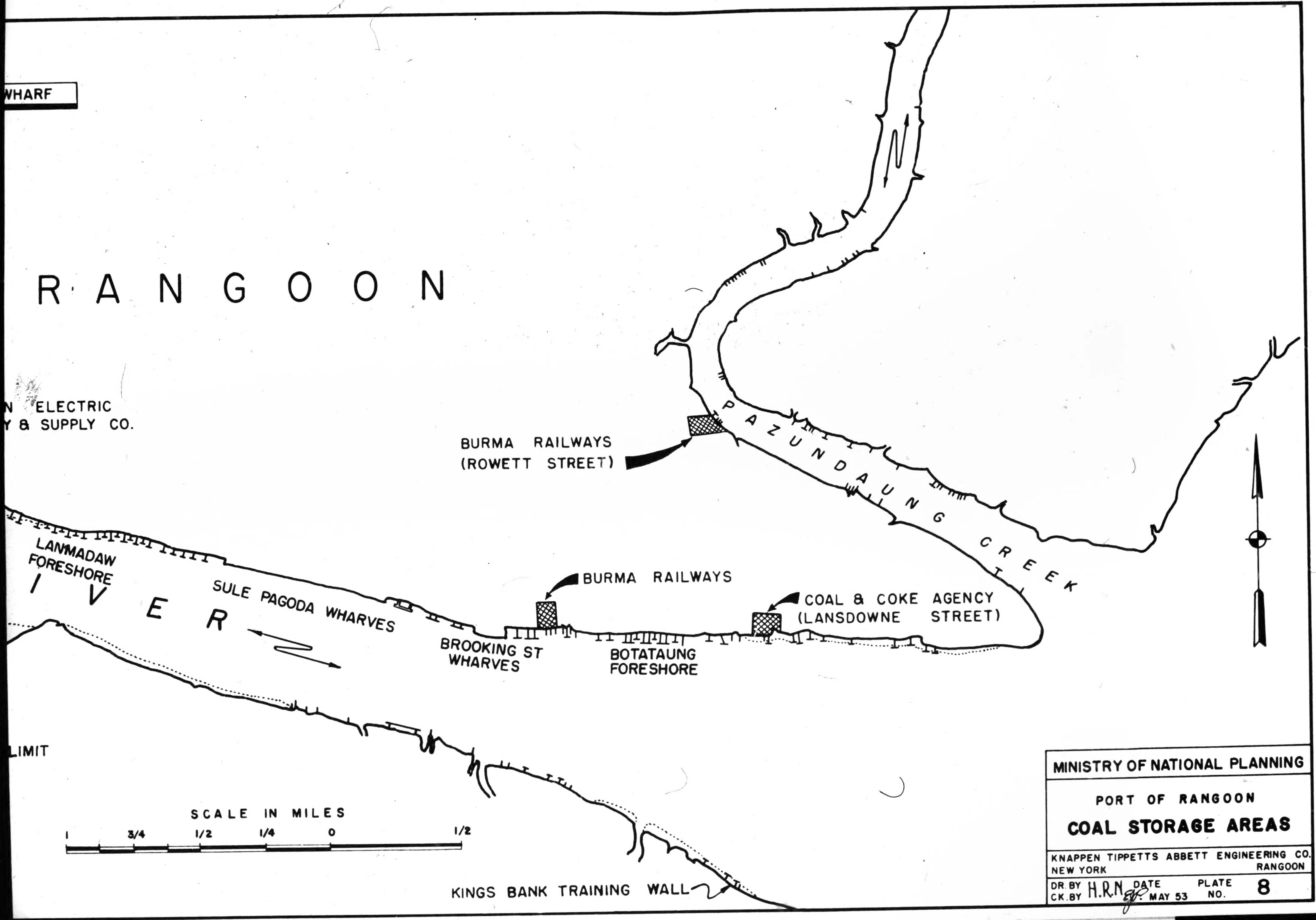
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BOTATAUNG
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MINISTRY OF NATIONAL PLANNING

PORT OF RANGOON

COAL STORAGE AREAS

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about 300 consumers by rail and trucks. The Commissioners for the Port of Rangoon do not maintain at present their own coal storage at Rowett Estate, preferring to take the coal from the storage of the Agency when needed. The Inland Water Transport Board (Dalla Dockyard and Rangoon Foundry) receive their coal either from ship or from the Agency's yard. The coal requirements of the Burma Navy are negligible. It is generally intended to maintain in stock a three-months' supply of coal; however, the actual stocks are much less and presently appear to be not more than 15,000 to 20,000 tons. There are no special bunkering facilities, and very few ships take coal in Rangoon since it is cheaper in Calcutta. For the occasional partial coaling, the coal is loaded from storage into lighters by coolies, and from lighters to ships in midstream (see Plate 8).

The coal is unloaded from ships into lighters by stevedores, organized in the Coal Workers Loading and Unloading Cooperative Society. The coal is loaded in the hold of the ship into wooden tubs of about 1,000 to 1,200 pounds capacity, then hoisted from the hold to a chute which spills the coal into the lighters. The average stevedore's gang consists of one foreman, two winchers, two tippers at the chute, one hooker in the hold, and 12 men, or a total of 18 men. Generally no more than four hatches can be worked in one shift, or five in one shift and three in another, and only one ship can be unloaded at a time. Ordinarily two nine-hour shifts are worked, with one-hour rest periods in each shift. However, with overtime, the net working time may amount to 17 or 18 hours per day. The coal is transported to shore depots by lighters of the Rangoon Cargo Boat Owners Association. The lighters are unloaded by coolie laborers who carry the coal in head baskets. These laborers usually work one eight-hour day shift, but the labor at the depot of the Coal and Coke Agency usually work from sunrise to sunset. The stevedores and shore laborers as yet are predominantly South Indians.

The average rate of discharge from ship into lighters does not exceed 1,500 tons per day (two shifts). The ship's load is limited by the depth in the approaches to the Port of Calcutta and averages 6,000 to 6,500 tons. The average discharge time of a ship with 6,000 tons of coal is about four days and the demurrage-free time of ship is about ten days (at 600 to 750 tons per day). It is only when two or three ships arrive within a few days of each other that the demurrage-free time is fully used.

Serious handling difficulties and delays occur in the unloading from lighters to storage. Even when only one ship is unloaded at a time, the unloading from lighters to storage lags several days behind. At the end of each day several lighters remain unloaded and the tonnage of this floating storage increases daily until the discharge of the ship is completed. When two ships are discharged one after another the storage in the lighters often reaches several thousand tons, particularly when not all four coal yards can be used simultaneously. Thus it is difficult to avoid the demurrage charges which amount to K2.50 per day per ton of registered capacity of the lighters and are due after 72 hours of demurrage-free time.

The coal handling is paid on a tonnage basis. The cost of unloading from ships to lighters is K1.00 per ton. Of this amount the stevedore receives K0.12 per ton for his gear, overhead and other costs; the remaining K0.88 per ton is paid to the Coal Workers Loading and Unloading Cooperative Society for distribution to its members. For lighterage of coal from ship to shore the Rangoon Cargo Boat Owners Association is paid K5.00 per ton. The contractor handling the coal on shore receives various payments per ton, depending whether the coal is unloaded from lighters to storage, or from storage to truck or railway car, or directly from the lighter to railway car. The cost of carrying coal from lighters to storage is K1.88 per ton. Thus the total handling cost from ship to storage equals K7.88 per ton. The cost of loading trucks and railways cars from storage is K0.95 per ton. At least 50% of the coal is handled twice at storage; therefore, the cost varies from K7.88 to K8.83 per ton, or an annual average handling cost of K8.36 per ton. In these costs lighterage, which could be eliminated by a coal-handling wharf, represents nearly 64% of the total of handling from ship to storage.

d. Export and Import Petroleum, Oil and Lubricants

Import of these products now represents over 16% of the foreign import commerce. Export amounts to less than 2% of the export trade. Before the war the petroleum industry played a major role in the economy of Burma. For the last few years before military activity the production of crude oil averaged about 1,100,000 tons per year. The petroleum was transported through a ten-inch pipeline from the producing oil fields in the upper Irrawaddy Basin in the Yenangyaung area to the refineries at Syriam on the eastern bank of the Rangoon River just below the confluence with the Pegu River, a distance of over 300 miles. The greater part of the petroleum products was exported to India, and in fiscal year 1940–41 the export tonnage amounted to 774,000 tons. During the military activities the refineries were demolished, at least one-half of the pipeline rendered unserviceable, all of the pumping stations were destroyed, and essentially all of the producing wells were either destroyed or damaged to the extent that repair is questionable.

Since cessation of hostilities, a small number of wells have been placed in production by the Associated Oil Companies, a joint venture by the Burmah Oil Company, the Indo-Burma Petroleum Company, and the British Burma Oil Company, and a small refinery has been constructed at Chauk in the production area. The output of this refinery is now about 2,000 barrels per day which probably can be stepped up to about 2,500 barrels per day. The production of the refinery is able to supply no more than the demands of the northern sector of Burma and practically the entire production is moved to Mandalay for distribution.

The demands of the southern sector radiating from the Port of Rangoon will approximate 5,500 barrels per day. This would be the import tonnage required until further indigenous petroleum production is realized. The effect of the war on export and import of petroleum, oil and lubricants at the Port of Rangoon is as follows:

	Fiscal Year 1940–41 (tons)	*Fiscal Year 1950–51 (tons)*	*Fiscal Year 1951–52 (tons)*
Imports	86,000	113,200	124,100
Exports	774,000	18,600	21,300

While exports are indicated in the statistics, the only physically foreign export is a small quantity of wax to the United Kingdom; the remainder includes the aviation gasoline supplied to the various airlines, a small amount of fuel for ships and shipments from Rangoon to other parts of Burma.

The refined products from Chauk are transported by the riverine craft of the Inland Water Transport Board. Products shipped from Chauk to Rangoon by riverine craft are stored in the tanks of the Burmah Oil Company, either at the tank farm at Syriam or in their yards on the left bank of the Rangoon River just west of Monkey Point. The import of petroleum products and their distribution are handled exclusively by the Burmah Oil Company. The imported foreign petroleum products are received in seagoing tankers, practically all of them discharging into the Syriam tanks. Some tankers discharge their full cargo at the Port of Rangoon. Others which have drafts up to 30 ft. leave part of their load at Rangoon and then proceed under lesser drafts to such harbors as Calcutta which have less favorable entrance-channel conditions. The petroleum products are transferred from tankers to the shore storage tanks through pipelines.

From the Syriam tanks the products are again transferred by the pipelines to barges (six in number with about 100 tons capacity each) which move the cargoes to the Rangoon installation of the Burmah Oil Trading Company. At these installations the products are placed in drums and tins to be transported to consumer by riverine craft, railway and, mostly, by truck. For servicing ships with fuel oil, the Burmah Oil Company operates one small tanker with a capacity of 110 tons and another similar craft for coastal service. The lubricants are received in drums and tins, mostly over the general cargo wharves; some cargoes are lightered and unloaded at the Rangoon yards of the Burmah Oil Company. The handling of import and export petroleum, oil and lubricants is carried out independently from other cargo handling, and does not interfere with other handling operations.

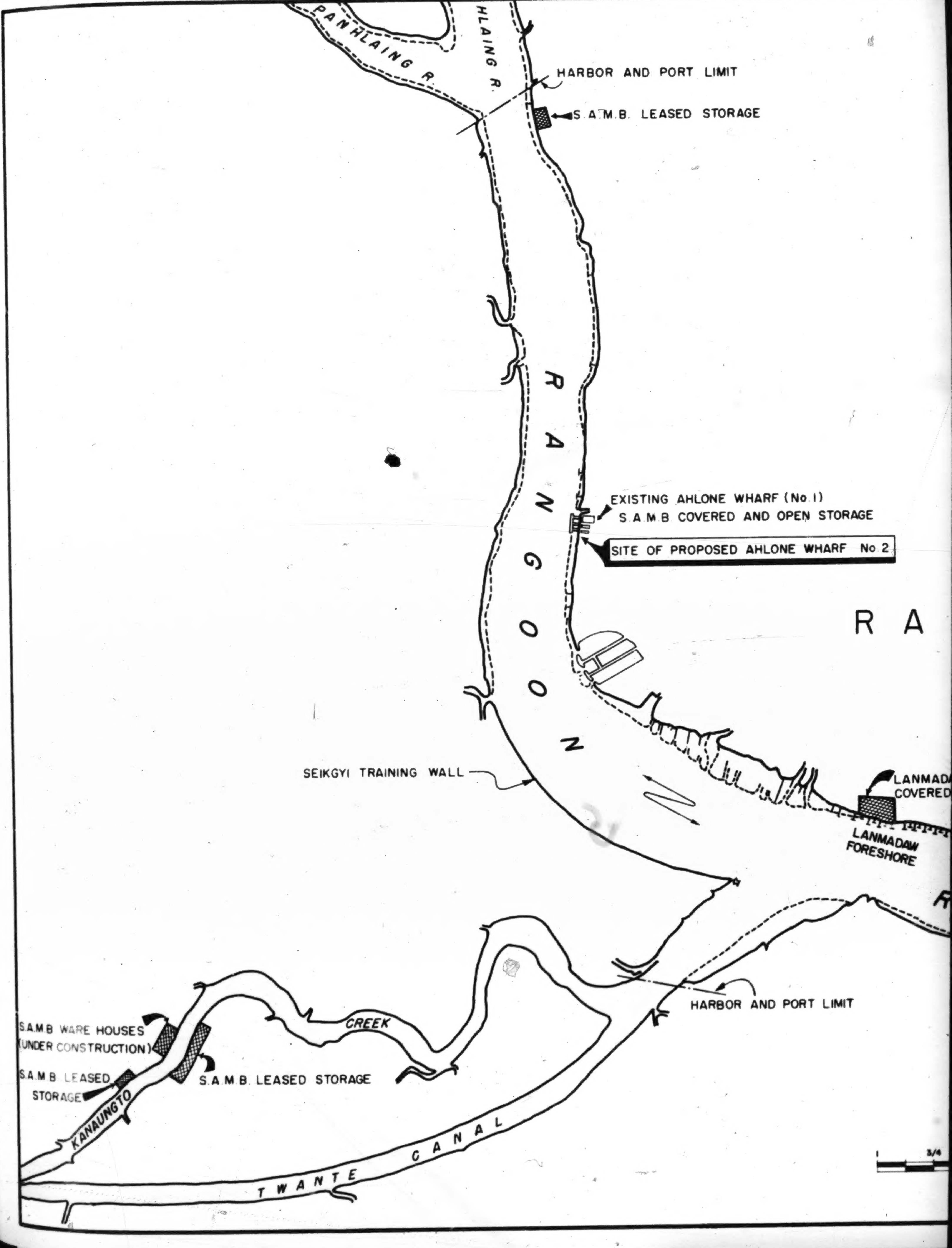
e. Import of Salt

The import of salt presently amounts to not over 2 to 3% of the total import trade. Until recently salt was received in bulk, loaded into lighters, transported to the Government Salt Depot on Pazundaung Creek, and unloaded and stored by coolies who were mostly women and who carried the salt in small head-baskets to the warehouses. The import of salt in bulk is now prohibited and the salt is received in bags in small consignments as general cargo over the wharves at the same handling rate as general cargo. Nearly all salt produced in Burma is obtained by evaporation from sea water. The largest source of supply is the Amherst district at the southern mouth of the Salween River. On a smaller scale, salt is produced in the delta area at Labutta, along the Arakan coast, and in other coastal sections.

f. Export of Rice

Rice is the main export commodity of Burma. Before the war total exports of rice approximated 3 million tons per year; in 1951 and 1952 it was about 1·3 million tons. About 75 to 80% of total rice exports are shipped from the Port of Rangoon. In fiscal year 1940–41 the shipment of rice from Rangoon was 2·2 million tons; in 1950–51 it amounted to slightly over 1 million tons or nearly 81% of the total exports from the port. It decreased to 840,700 tons in 1951–52, and represented nearly 75% of the export trade. It is estimated that by 1959–60 the export of rice from Rangoon will approach prewar volume and will be about 2,125,000 tons.

All export rice is bought in Burma, stored, loaded on ships, and then sold f.o.b. to foreign buyers by the State Agricultural Marketing Board, a government agency. The SAMB sells about two thirds of the rice purchased by major buyers on a government-to-government basis and the remainder on a private trade or tender basis. Prior to the establishment of SAMB, the rice crop was purchased from cultivators by landlords and re-sold to exporters and brokers. Whenever the market price fluctuation made it appear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HARBOR AND PORT LIMIT
S.A.M.B. LEASED STORAGE
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EXISTING AHLONE WHARF (No. 1)
S.A.M.B. COVERED AND OPEN STORAGE
SITE OF PROPOSED AHLONE WHARF No 2
R A
SEIKGYI TRAINING WALL
N
LANMADA
COVERED
LANMADAW FORESHORE
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HARBOR AND PORT LIMIT
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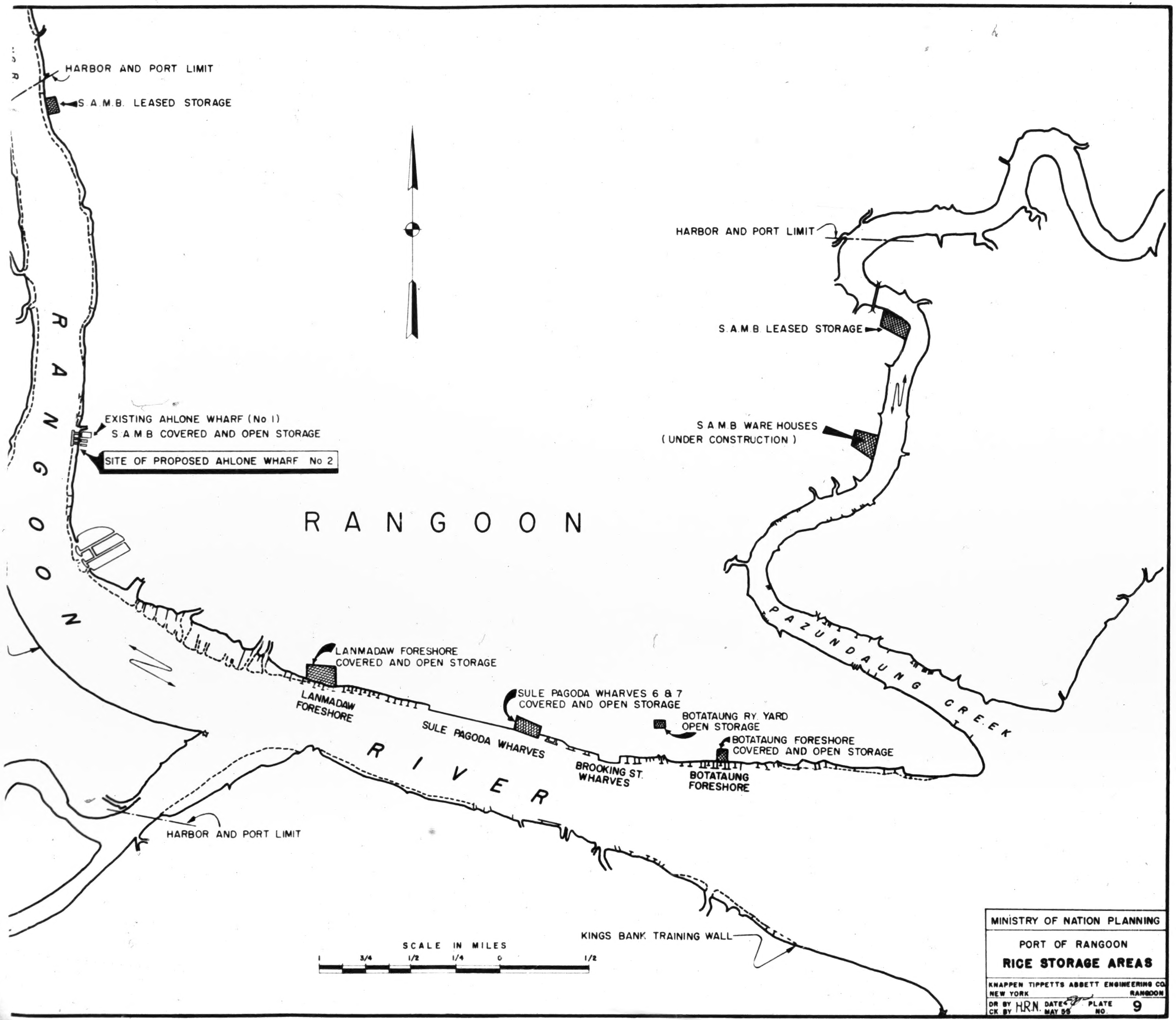
HARBOR AND PORT LIMIT
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EXISTING AHLONE WHARF (No 1)
S.A.M.B COVERED AND OPEN STORAGE
SITE OF PROPOSED AHLONE WHARF No 2
RANGOON RIVER
RANGOON
LANMADAW FORESHORE COVERED AND OPEN STORAGE
LANMADAW FORESHORE
SULE PAGODA WHARVES 6 & 7 COVERED AND OPEN STORAGE
SULE PAGODA WHARVES
BROOKING ST. WHARVES
BOTATAUNG RY. YARD OPEN STORAGE
BOTATAUNG FORESHORE COVERED AND OPEN STORAGE
BOTATAUNG FORESHORE
HARBOR AND PORT LIMIT
S.A.M.B LEASED STORAGE
S.A.M.B WARE HOUSES (UNDER CONSTRUCTION)
PAZUNDAUNG CREEK
HARBOR AND PORT LIMIT
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MINISTRY OF NATION PLANNING

PORT OF RANGOON

RICE STORAGE AREAS

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advisable, the rice was stored in the districts. The bulk of rice was delivered in lighters, directly to the ship's side, and practically all export took place in the period from January to May. At present the cultivators sell their crops directly to SAMB or to the mills. The price is fixed by SAMB for the entire season, so that the sellers have no incentive for holding and storing their crop. Financially they are usually not in a position to do so, and SAMB is practically compelled to buy the rice immediately after it is harvested. On the other hand, due to the new selling methods, the shipping of rice extends over the entire year. Furthermore, due to conditions of insurgency and danger of pilferage, storage of rice in districts is often impracticable. As a result of these conditions SAMB must find in and around Rangoon adequate storage for a substantial percentage of the export tonnage (see Plate 9).

Rice is delivered in lighters to the ship's side in midstream either directly from the mills or from the warehouses located along the waterfront of Rangoon and on the banks of Pazundaung Creek, of Kanaungto Creek, and other neighboring areas. The delivery of rice to warehouses is by rail, truck or lighter; from warehouses to ship by lighters. The depths at the face of numerous pontoon jetties at the waterfront are sufficient for riverine craft only, and the sea-going vessels taking export cargo are moored in the midstream of Rangoon River. The only exception to these conditions exists at the Ahlone Wharf, which was assigned to SAMB by the Commissioners for the Port of Rangoon for the direct loading of rice from wharf to ships. Thus far, only a few ships have loaded from Ahlone Wharf. However, loading from the Ahlone Wharf can be organized to allow the shipping of a substantial tonnage by mechanical cargo handling with resulting reduction of costs.

According to the records of SAMB the percentages of rice shipped from the Port of Rangoon with and without intermediate storage were:

RICE ARRIVALS IN RANGOON

Method of Arrival	*Per cent* *1951*	*1952*
By Lighter (loaded direct to ships)	40·5	44·5
By Lighter (to warehouse)	23·8	20·0
By Rail	33·3	32·7
By Truck	2·4	2·8
Totals	100·0	100·0

Thus, about 64% of all rice now shipped from Rangoon arrives in lighters, about 33% by rail, and about 3% by highway. At present, the rice lighters arrive in Rangoon from the districts under armed guard convoys; they can be unloaded directly into a ship only if by coincidence there is a vessel awaiting cargo. However, should the improvement of internal conditions permit better timing of rice shipments from districts, it can be assumed that even then not less than 40 to 45% of all export tonnage will have to be stored prior to shipment. The length of storage time and the amount stored will depend on the status of the sales contracts negotiated with buyers by SAMB.

As of February 1953 SAMB had storage space with a total capacity of 163,650 tons rented in the harbor area either from the Commissioners for the Port of Rangoon or from private owners. This storage space was distributed approximately as follows:

Rented from the Commissioners:	
Ahlone Wharf—at present	9,000 tons
Lanmadaw Embankment	18,200 ,,
Sule Pagoda Wharves	10,950 ,,
Lewis Street Godown	1,000 ,,
Botataung Embankment	47,100 ,,
	86,250 tons
Others	77,400 ,,
Total	163,650 tons

Additional warehouses outside the port area are under construction. As the total tonnage stored during 1952 was about 550,000 tons, the average storage time was about 108 days per ton. The storage of rice in some of the godowns of Sule Pagoda Wharves should be considered as a strictly temporary arrangement, explainable only by the fact that at present berths Nos. 6 and 7 cannot be used for handling of general cargo, but are used for lighterage. The godowns at Lanmadaw and Botataung foreshores are intended for the needs of riverine and coastwise trade. The facilities available at present at the foreshores appear to be insufficient as the traffic there is seriously congested. To alleviate these conditions it is recommended that all rice delivered to warehouses in lighters (at present about 20 to 25% of the total export tonnage) should be diverted to warehouses of SAMB located outside the port area. Rice tonnage delivered to warehouses by rail and truck (at present about 25% of the total tonnage) should be diverted progressively to Ahlone Wharf for direct loading from wharf to ships.

For handling of bagged rice on shore and in the lighters, SAMB uses contractors. This year there are three, one of whom is the Direct Handling Department of SAMB; the others are the Rangoon Workers Cooperative Society and the Dock Workers Cooperative Society. Each contractor is assigned a definite group of godowns or warehouses. At this time, about one-half of the shore coolie labor is Burmese and the remainder Indian. Shore labor works one eight-hour day shift, in gangs of 30 to 40 men. The rice bags are carried by the men on their backs from the warehouses to the lighters, or to the ship's side at the Ahlone Wharf. The number of gangs used depends on the distance from warehouses to lighters. These distances vary approximately from 250 to 600 ft. On the average 700 to 1,000 men are used daily; however, at times of concentrated shipping the number of men required is increased materially and a shortage in this type of labor is often experienced.

The handling of rice bags on the ship, the operations which include loading in slings in the lighter, hoisting the load by ship's gear, lowering into the ships' holds, stowing, and packing is accomplished for SAMB and buyers by private stevedoring companies. The stevedoring operations usually are conducted in two shifts, from 6 a.m. to 3 p.m. and from 7 p.m. to 3 a.m. In a great number of instances overtime is required, and the net working time may be 21 hours. The number of men used in the stevedoring gangs is dependent on two factors, whether small or large bags are used and whether the cargo is destined for a short coastwise trip or for a long ocean voyage. Where a short trip is expected the bags are packed tightly in the hold and the gang usually is comprised of one working foreman, two winchmen and 16 men. Where a long ocean voyage is contemplated the packing must be done carefully with sufficient passages left for ventilation. The gang is usually of one working foreman, two winchmen, 14 men and four experienced packers.

Three sizes of bags are used: 160 lbs. (14 bags per long ton), 210 lbs. (about 10·67 bags per ton) and 224 lbs. (10 bags per ton). Previously, most of the shipments west of the Suez Canal were of the 224-lb. size. At present, about 20% of the export is in 160-lb. bags and the remainder in the 210-lb. size.

The cost of carrying rice bags to the lighters depends on the distances from storage; consequently a set of rates is fixed for each godown or group of godowns. The maximum and minimum prices per 100 bags and per long ton are as follows:

	Charge in Kyats		
	Maximum	*Minimum*	*Per Ton*
(1) Carrying bags from lighters to godowns and stacking			
For 100 bags at 160 lbs.	34.00	20.00	4.76 to 2.80
For 100 bags at 210 lbs.	37.00	22.00	3.94 to 2.35
(2) Carrying bags from godowns to lighters			
For 100 bags at 160 lbs.	32.00	18.00	4.48 to 2.52
For 100 bags at 210 lbs.	34.00	20.00	3.63 to 2.13
(3) Carrying bags from cars or trucks to storage and stacking (Ahlone Wharf)			
For 100 bags at 160 lbs.	24.00	22.00	3.22 average
For 100 bags at 210 lbs.	26.00	24.00	2.67 ..
(4) Carrying bags from storage to ship's side (Ahlone Wharf)			
For 100 bags at 160 lbs.	22.00	20.00	2.94 average
For 100 bags at 210 lbs.	24.00	22.00	2.45 ..

The lighters for the transport of rice to the ship's side ordinarily vary in capacity from 50 to 150 tons of cargo. About one half of the lighters are supplied by the Inland Water Transport Board and the remainder by the private companies which are included in the Rangoon Cargo Boat Association. The rate charged for lighterage is K4.00 per long ton for a distance not exceeding five miles and for greater distances the charge is K6.00 per ton. The costs of the stevedoring work for the unloading of rice from the lighters and the loading and storing in the hold of the ship are paid partly by SAMB and partly by the buyer. Since SAMB sells the rice f.o.b., it pays only for slinging of the cargo in the lighters and for hoisting it over the ship's rail. This slinging fee is K0·625 per ton. The cost of the balance of the stevedoring work of lowering the load into the hold and for stacking and packing is paid by the shipping agency. The present rate of this charge is K1.75 per ton. Thus, the total costs of stevedoring are about K2.38 per ton.

The present total average cost of handling from arrival of a shipment by lighter at the storage, transport to ship by lighter and stacking in the hold of the ship, will approximate:

	For 160-lb. bags	*For 210-lb. bag*
Carrying from lighter to storage and stacking	K3.78	K3.17
Carrying from storage to lighters	3.50	2.83
Lighterage	4.00	4.00
Stevedoring	2.38	2.38
Total handling costs per ton	K13.66	K12.38

At Ahlone Wharf, where the cargo can be loaded directly from wharf to ship, the present total average cost of handling will be about:

	For 160-lb. bags	*For 210-lb. bags*
Carrying from cars or trucks and stacking	K3.22	K2.67
Carrying from storage to ship's side	2.94	2.45
Stevedoring	2.38	2.38
Total handling costs per ton	K8.54	K7.50

Studies of the records of SAMB and of various shipping and stevedoring companies indicate that loadings of 150 to 180 tons per hook per shift are often recorded. However, the average rate of loading per ship per day (for two shifts) does not exceed 1,000 tons. In general the loading of rice is started when the ship is unloading general cargo at the wharf. Lighters loaded with rice are brought alongside the ship that is moored at the wharf. When the unloading of general cargo is completed, the ship is moved to midstream where the loading of rice is continued.

Where such procedures are used to expedite loading they often tend to reduce the average rate of uninterrupted loading of ships in midstream. On the assumption of an average of five hooks, the rate of loading 1,000 tons per ship per day corresponds approximately to 100 tons per hook per shift. However, the net working time in two stevedoring shifts often exceeds 16 hours so that the rate per hook per hour will be from 10 to 12 tons. The load of rice taken by each ship may vary from a few hundred tons to 8,000 tons and more. The average load is about 5,000 tons. Generally, four to six ships are being loaded simultaneously, with a maximum of 15 to 17 ships during peak periods of rice export.

g. Export of Timber

From 1937 to 1941 the average annual export of timber from Burma was about 215,000 cubic tons of teak and 40,000 cubic tons of other hardwood. The total timber export of teak and hardwood from the Port of Rangoon during fiscal year 1940–41 was about 193,000 tons. The postwar return of the timber trade resulted in 56,200 tons in 1950–51 and 59,200 tons in 1951–52 which approximated only a little over 5% of the annual export trade of that year. To a certain extent, the lack of recovery may be attributed to the use of substitutes by the major customers who were deprived of those products during the war years.

The State Timber Board is the government agency which controls all extraction, processing and export of timber. It also grants licenses to private mill owners and operates its own sawmills. The timber is shipped directly from the mills which are located principally on the banks of the Rangoon River and Pazundaung Creek. Timber cut to short lengths is bundled, loaded into lighters, and transported to the ship; long lengths are tied to the lighters and towed to the ship. The bundling of timber and loading of lighters are accomplished by the mill labor; loading from lighter to ship is done by the stevedoring companies. Timber practically never constitutes the entire cargo of the ship, but is loaded together with other export cargo. According to the stevedoring companies the rate of loading teak is about 25 tons per gang per shift and of other hardwoods about 18 tons. The stevedore gang is ordinarily composed of a foreman, two winchmen, and 14 laborers.

h. Export of Minerals

The mineral exports from Burma consist of tin, tungsten concentrates, lead, zinc concentrates, and nickel speiss. The export from Burma in the years from 1937 to 1941 averaged about 134,000 tons per year, with the maximum of 187,000 tons in fiscal year 1937–38 and a minimum of 91,000 tons in 1940–41. From the Port of Rangoon 72,200 tons of minerals were exported in 1940–41; the export volume has recovered only to 17,400 in 1950–51 and 22,200 tons in 1951–52. The 1951–52 export represents only a little over 2% of the total annual foreign export of the port.

The minerals are shipped to Rangoon by rail and stored in the Sule Pagoda Wharves area from which they are loaded on ships. For transfer to ships the minerals are loaded at the storage in steel tubs, which are then transported to the ship's side on tractor-drawn trailers. From there the tubs are hoisted by ship's gear, lowered into the hold and tipped. The loading of tubs at the storage is by hand. At present some experiments are being made with mechanical loading by means of shovels, draglines and other equipment. The tubs have no mechanical tipping arrangement and their tipping by hand in the ship's hold is tedious and difficult. Transfer of minerals from storage to the ship's side is handled by the dock labor of the Commissioners' Traffic Department. The hoisting to ship and loading in the hold is done by private stevedoring companies. The minerals are generally shipped in lots of 1,500 to 2,000 tons. The loading on ships overlaps with unloading of the general cargo from the same ship. No data are available on the exact rate of loading of minerals, but it necessarily must be lower than the rate of unloading of general cargo. As the tonnage of exported minerals represents less than 5% of the tonnage of imported cargo, the over-all cargo handling rates are not substantially affected.

15. RIVERINE AND COASTWISE TRADE

The riverine trade, the lighterage to and from ocean-going vessels, and the coastwise trade of seagoing schooners are handled at the five foreshore installations of the Commissioners for the Port of Rangoon. Proceeding downstream along the left bank of the Rangoon River, these installations are: Kemmendine foreshore; Lanmadaw foreshore; Lewis Street pontoon and Judah Ezekiel Street lower pontoon; and Botataung foreshore. The fifth installation is the Pazundaung foreshore on Pazundaung Creek. The

Kemmendine and Pazundaung foreshores handle a very minor part of the total commerce, and the magnitude of operations there presents no major problems. The principal foreshores handling the bulk of commerce are Lanmadaw and Botataung.

The total river-borne trade at the Port of Rangoon in the period from fiscal year 1946–47 through 1951–52 was shown in Table XII–5. The total riverine trade of 654,259 tons handled in fiscal year 1951–52 was shown as 497,784 tons landed and 156,475 tons shipped. In the same fiscal year there was a total of 498,270 tons of seaborne cargo handled at the foreshores, or about 25% of the total seaborne trade of the Port of Rangoon. Of this total 412,744 tons were cargoes lightered to and from seagoing vessels, and 85,526 tons comprised the coastwise trade of seagoing schooners. Thus, the total riverine and seaborne commerce handled at the foreshores during fiscal year 1951–52 approximates 1,152,929 tons. A breakdown of this total tonnage is shown by Table XII–6. A study of this table discloses that the annual tonnages over the Lanmadaw and Botataung foreshores amount to 80% of the total commerce handled over foreshores.

a. Lanmadaw Foreshore

The principal use of this foreshore is to provide berthing space for the delta services of the Inland Water Transport Board and for privately owned launches serving the Irrawaddy River delta area, for seagoing schooners used in coastwise trade, and for the lighters of IWTB and the Rangoon Cargo Boat Owners Association used in the transfer of cargo to and from the ocean vessels anchored in midstream of the Rangoon River. At present there are 16 major pontoon jetties, two measuring 20 ft. by 240 ft. and 14 at 20 ft. by 120 ft., a total of nearly 2,200 ft. of berthing space. In addition, there are eight small cargo jetties which have little commercial use because of the shallow depths alongside. The Lanmadaw foreshore section has a river frontage of about 4,800 ft. with good depths at the lower 14 jetties. The foreshore is illustrated in detail on Plate 5 entitled "Proposed Reconstruction—Lanmadaw Foreshore."

As of March 1953 the approximate floor area of the Commissioners' warehouses at the Lanmadaw foreshore was:

	Nissen Huts	*Steel Frame and CSM*	*Brick and Stucco*	*Open Shed*	*Total sq. ft.*
Total area, sq. ft.	105,550	235,451	9,800	12,960	363,761
Leased to SAMB	54,388	124,388	9,800	—	188,688

The warehouses along the foreshore are leased by the Commissioners on a monthly basis. In the prewar period they were tenanted mostly by small traders who stored their goods for shipment to the delta area or distributed at coastal ports. Consumer's goods were and still are landed and generally removed immediately by the consignees without intermediate storage. Only a part of the warehousing was used in the rice export trade. At present, more than 50% of available space is rented by the State Agricultural Marketing Board for rice storage.

TABLE XII – 6

TONNAGES HANDLED AT RANGOON FORESHORES DURING FISCAL YEAR 1951–52

Foreshores	*River-borne*		*Seaborne*				*Total (tons)*	*Per cent of Total*
			Lighters		*Seagoing Schooners*			
	Landed (tons)	*Shipped (tons)*	*Landed (tons)*	*Shipped (tons)*	*Landed (tons)*	*Shipped (tons)*		
Kemmendine	69,014	1,752	—	3,349	5,017	105	79,237	6·9
Lanmadaw	218,004	105,534	10	170,650	28,492	15,580	538,270	46·6
Lewis Street and Judah Ezekiel Street	17,649	4,813	4	218	2,230	17,771	42,685	3·7
Botataung	147,132	32,291	660	189,897	4,211	10,213	384,404	33·4
Pazundaung	45,985	12,485	38,049	9,907	561	1,346	108,333	9·4
	497,784	156,875	38,723	374,021	40,511	45,015		
Total	654,659		412,744		85,526		1,152,929	100·0

Of the 218,000 tons of river-borne commerce landed at the foreshore about 68,000 tons, or 29%, were bagged rice. About 25,000 tons of the rice were for local consumption and the balance for export. Out of 170,650 tons shipped out in lighters about 87,500 tons were export rice. Thus, the total tonnage of rice, landed and shipped, was 151,500 tons or about 28% of the total tonnage handled at the foreshore. Seagoing schooners landed 14,690 tons of salt from the Amherst district.

b. Botataung Foreshore

This foreshore extends for about 1,900 ft. along the Rangoon River, from the Commissioners' Work Shops to the grounds of Bombay Burmah Trading Corporation. However, the area from the Commissioners' Work Shops to Thompson Street is occupied by the Botataung Pagoda, the general stores of the Commissioners, and menial quarters; the area between Strand Road and Hoppers Road is assigned to the living quarters of the Port Police. The remaining area between Hoppers Road and the river, about 1,200 ft. long and 450 ft. wide, is occupied by the warehouses of Botataung foreshore. Before the war the Botataung foreshore was known as the Mandalay Depot and served mostly the craft of the Irrawaddy Flotilla Company which operated between Rangoon and Mandalay. At present the Botataung foreshore provides berthing space for the Inland Water Transport Board craft in the Mandalay–Rangoon riverine trade, lighters hired by the State Agricultural Marketing Board in the rice trade, seagoing schooners engaged in the coastwise trade, and harbor craft of the Commissioners' Civil Engineering Department.

The total volume of cargo handled at the foreshore in fiscal year 1951–52 was about 384;400 tons or about one third of the total tonnage handled at all of the Commissioners' foreshores. There are presently five pontoon jetties along the foreshore, one dimensioned 20 ft. by 100 ft, one 20 ft. by 120 ft., and three 40 ft. by 200 ft., a total berthing space of about 820 ft. The physical features of the Botataung foreshore are shown on Plate 6 entitled "Proposed Reconstruction —Botataung Foreshore."

As of March 1953 approximate floor area of the Commissioners' warehouses at Botataung foreshore was:

	Nissen Huts	*Steel Frame and CSM*	*Total sq. ft.*
Total area sq. ft.	9,150	205,532	214,682
Leased to SAMB	9,150	196,732	205,882

The warehouses along the foreshore are leased by the Commissioners on a monthly basis. In the prewar period they were rented mostly by traders for storage of goods to be shipped on the Irrawaddy Flotilla Company craft in the Mandalay trade. At present more than 95% of storage space is rented by the State Agricultural Marketing Board for storage of export rice.

Out of approximately 147,000 tons of river-borne commerce landed at the foreshore, about 49,000 tons, or 33%, were bagged rice. Of the 189, 897 tons shipped out in lighters, 183,200 tons, or 97%, were export rice. Thus, the total tonnage of rice landed and shipped was about 232,200 tons, or approximately 61% of all tonnage handled at the Botataung foreshore in the fiscal year 1951–52. Of the 85,000 tons landed at the foreshore from privately owned riverine craft, about 45,000 tons were sand for construction.

c. Operating Conditions

At the Lanmadaw foreshore the berthing space was inadequate for the trade and serious congestion was experienced there; however, the warehouse space was considered ample. In the prewar period, the delta vessels of IWTB used 11 jetties; now they are assigned five. While the postwar trade is much less than prewar, the reduction in riverine commerce is offset by the increased use of that area for the rice export trade. SAMB now has assigned five jetties and over 50% of the warehouse space for rice transfer and storage. With the additional demand by private craft the Lanmadaw foreshore already is congested, and with the return of trade to normal conditions it is likely that the congestion will become serious. All cargo handling is by coolie labor. The goods are carried from warehouse to jetty for distances up to 600 ft. and in only a few instances are trucks used. Several warehouses are installed parallel to the shoreline and thus block access to those farther inshore. Only a few warehouses are provided with railway connections. The road along the waterfront is of insufficient width, and is crowded by venders and refugees who live in sampans moored along the bank. To cope with a return to normal riverine and coastwise trade the Lanmadaw foreshore would require improvement and extension of the existing facilities.

The character and utilization of the Botataung foreshore have changed basically since the prewar period. Before the war the foreshore was used principally in the Rangoon–Mandalay trade with three of the jetties assigned to the Irrawaddy Flotilla Company (now IWTB). At present, the main user of the foreshore is the State Agricultural Marketing Board which rents practically the entire storage space.

The arrangement of warehouses, railway sidings and other installations at Botataung is more convenient for efficient cargo handling operations than at Lanmadaw foreshore and less congestion is experienced. It may be noted that at Botataung foreshore 389,000 tons of cargo were handled on approximately 700 ft. of berthing space, while at Lanmadaw foreshore with berthing space of 2,100 ft. the volume of handled cargo was 538,000 tons. This difference of the ratio of handled cargo to the length of berthing space can be explained partly by the fact that the rate of handling of uniform cargo such as bagged rice is much higher than the rate of handling of miscellaneous goods. At the Botataung foreshore rice represents over 60% of all cargo handled, while at Lanmadaw it is only about 28%. However, the average ratios of tons per foot of berthing per year at Botataung and Lanmadaw are 550 and 256 respectively. The better cargo-handling conditions at the Botataung foreshore certainly is one of the reasons for the higher cargo-handling rate. The available berthing space is insufficient even at present. With the return of normal economic conditions and the resulting substantial increase in the trade with upper Burma and in the coastal trade, the improvement and enlargement of existing accommodations will be necessary.

16. PORT DEVELOPMENT PROGRAM

The basic function of a commercial port is to serve as a point of transfer of passengers and cargo between vessels and shore and from shore facilities to railway, highway and inland waterways carriers. The degree of efficiency of a commercial port may well be indicated by the turn-around time of cargo vessels. The shorter this time the better is the utilization of the port capacity. Furthermore, the length of the turn-around time to a large extent influences the freight rates, and reflects itself in the general economy of the country. This is particularly true in Burma which has a relatively large export and import trade. To accomplish the transfer of goods between ship and shore in the most efficient way, in the shortest possible time and at least expense, the following requirements must be met:

The arriving ship must be able to reach the unloading berth with a minimum of maneuvering and without loss of time.

Sufficient berthing space must be available at all times so unloading operations can begin immediately after the arrival of the ship.

Cargo handling must be accomplished in the shortest possible time with no interruption of operations during the working hours.

Lighterage should be eliminated as much as possible, and the cargo handled directly between ship and wharf or, in case of bulk cargo, directly between ship and storage.

The transport of cargo from wharf to transit sheds and the stacking of cargo in the transit sheds must be coordinated with the unloading of the ship to eliminate any delays due to too slow cargo handling on the wharf.

The stacking of cargo in transit sheds must be made rapidly to allow full utilization of storage space.

Sufficient transit-shed and warehouse space must be provided, and the removal of cargo from transit sheds accomplished in such a way as to avoid delays of berthing and start of unloading of the next ship.

Adequate highway connections and railway sidings must be provided at the wharves to assure smooth and speedy clearance of goods.

In the preceding sections, deficiencies were pointed out in the handling of import and export of foreign general cargo, the export of rice, the import of coal, and the lack of coordinated marine repair facilities. Separate reports have been submitted on these problems. In the following discussions the findings are included in summary form. Stated in broad terms the present problems fall into two classes: one, labor unrest and low production efficiencies; and, two, the lack of facilities and equipment to permit a mechanized program of cargo handling. Insofar as practicable it is necessary to mechanize the handling of general cargo, rice, coal and other commodities. Existing facilities are barely sufficient for handling the present commerce; to provide for the increase in traffic new facilities will be required.

a. Commerce Requirements

Economic analyses indicate that the foreign trade which can be expected by fiscal year 1959–60 will approximate 4,505,000 long tons. Table XII-7 is included to show a breakdown of this tonnage by commodities and a comparison with the volumes of foreign trade experienced in fiscal years 1940–41 and 1951–52. It is to be noted in this tabulation that the forecast volume of the main export commodity (rice and rice products) approximately equals the volume exported in fiscal year 1940–41. Important redistribution of tonnages takes place among other commodities.

The export of petroleum, oil and lubricants is nearly eliminated because of the undetermined rate of recovery of the petroleum industry. The substantial increase in tonnage of imported general cargo is forecast in anticipation of the imports of capital equipment and materials required for realization of various industrial projects. The coal imports are based on the demands of the Rangoon area. With reference to general cargo it should be noted that it will be desirable in the future to handle at the wharves not only the imported general cargo but also the exported general cargo, salt imported in bags and the greater part of exported minerals. Thus, the total tonnage

TABLE XII – 7

FORECAST OF FISCAL YEAR 1959–60 FOREIGN COMMERCE AT THE PORT OF RANGOON

	1940–41		*1951–52*		*Forecast 1959–60*	
	Tons	*Per cent*	*Tons*	*Per cent*	*Tons*	*Per cent*
Imports						
General Cargo	958,300	68·70	463,800	60·38	1,300,000	74·90
Coal	326,700	23·47	164,400	21·40	300,000	17·30
Petroleum, Oil and Lubricants	86,000	6·17	124,100	16·15	85,000	4·90
Salt	23,100	1·66	15,900	2·07	50,000	2·90
Total	1,394,100	100·00	768,200	100·00	1,735,000	100·00
Exports						
Rice and Rice Products	2,192,000	61·70	840,700	73·67	2,125,000	76·62
General Cargo	317,700	8·94	197,500	17·30	380,000	13·72
Timber	192,900	5·43	59,200	5·20	165,000	5·95
Petroleum, Oil and Lubricants	774,100	21·79	21,300	1·88	10,000	0·36
Minerals	76,200	2·14	22,200	1·95	90,000	3·35
Total	3,552,900	100·00	1,140,900	100·00	2,770,000	100·00
Total Exports and Imports	4,947,000		1,909,100		4,505,000	

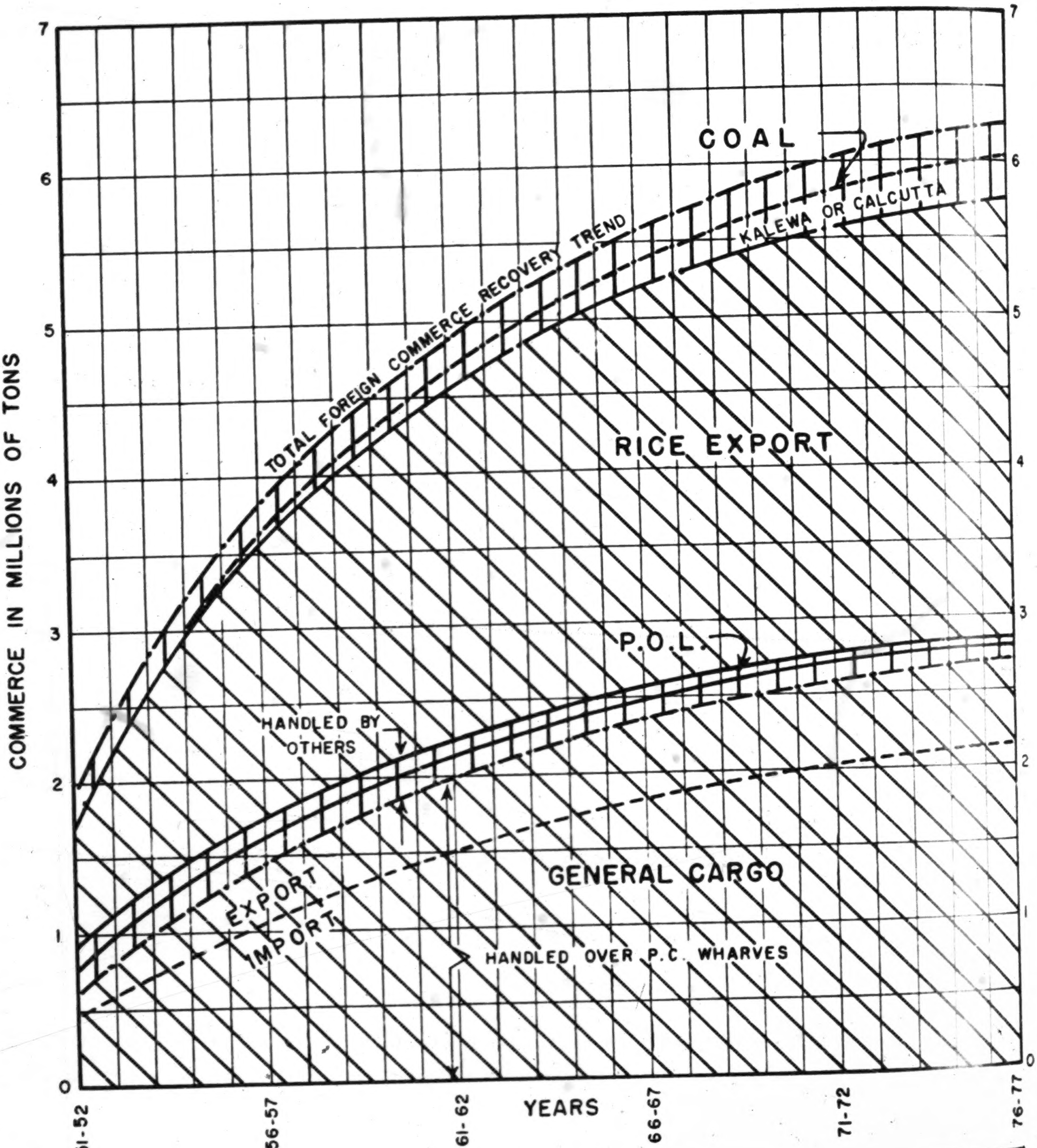
falling into category of general cargo to be handled at the wharves in the fiscal year 1959–60 would be:

Import of general cargo	1,300,000 tons
Export of general cargo	380,000 ,,
Import of salt	50,000 ,,
Export of minerals	90,000 ,,
Total	1,820,000 tons

In planning new major port facilities it is necessary to consider a greater period of time than that ending in 1959–60 in order to fit any new construction into an over-all plan of port development. To this end, it was necessary to establish the normal growth trend of the total foreign commerce, the effects of the war, and the recovery trend in the postwar period. As shown on Plate 11, the normal trend is indicated by an increase at a constant rate to a total of about 1,000,000 tons in 36 years, or approximately 27,800 tons per year, a very conservative estimate. The curve of the recovery trend passes through the coordinates of the commerce experienced in fiscal year 1951–52 and of the forecast commerce for fiscal year 1959–60. It intersects the curve of normal growth trend in fiscal year 1976–77 and from that year onward the continuation of normal development can be expected. Consequently, the recovery trend from 1951–52 until 1976–77 can be considered a commerce forecast for this 25-year period.

Plate 10 shows estimated breakdown of total foreign commerce into various commodities, from the present until fiscal year 1976–77. According to this chart the total tonnage of cargo to be handled at the general-cargo wharves will reach a 2,500,000-ton volume in 1969–70 and will be about 2,700,000 tons in 1976–77. The estimates of the future development of commerce are naturally based on the assumption of normal conditions and may be altered materially by unforseeable internal and world events.

In an economic forecast of the demands for raw and processed coal in Burma by fiscal year 1959–60, considering the needs of a comprehensive industrial development program, there would be required annually a supply of about 560,000 tons. In the trade area served by the Port of Rangoon, there would be required about 300,000 tons per year. There are two potential sources of this fuel; one, the existing foreign source at Calcutta; the other, the development of the indigenous coal deposits at Kalewa. For some years to come the supply will probably be furnished from either the one or the other or both sources, with economics as much a governing factor as the capability of the sources to supply the demands. For the purpose of this study, it is considered that the coal demand at Rangoon will vary from the present requirement of 200,000 tons to 300,000 tons by fiscal year 1959–60; that the Union of Burma Shipping Board will trans-



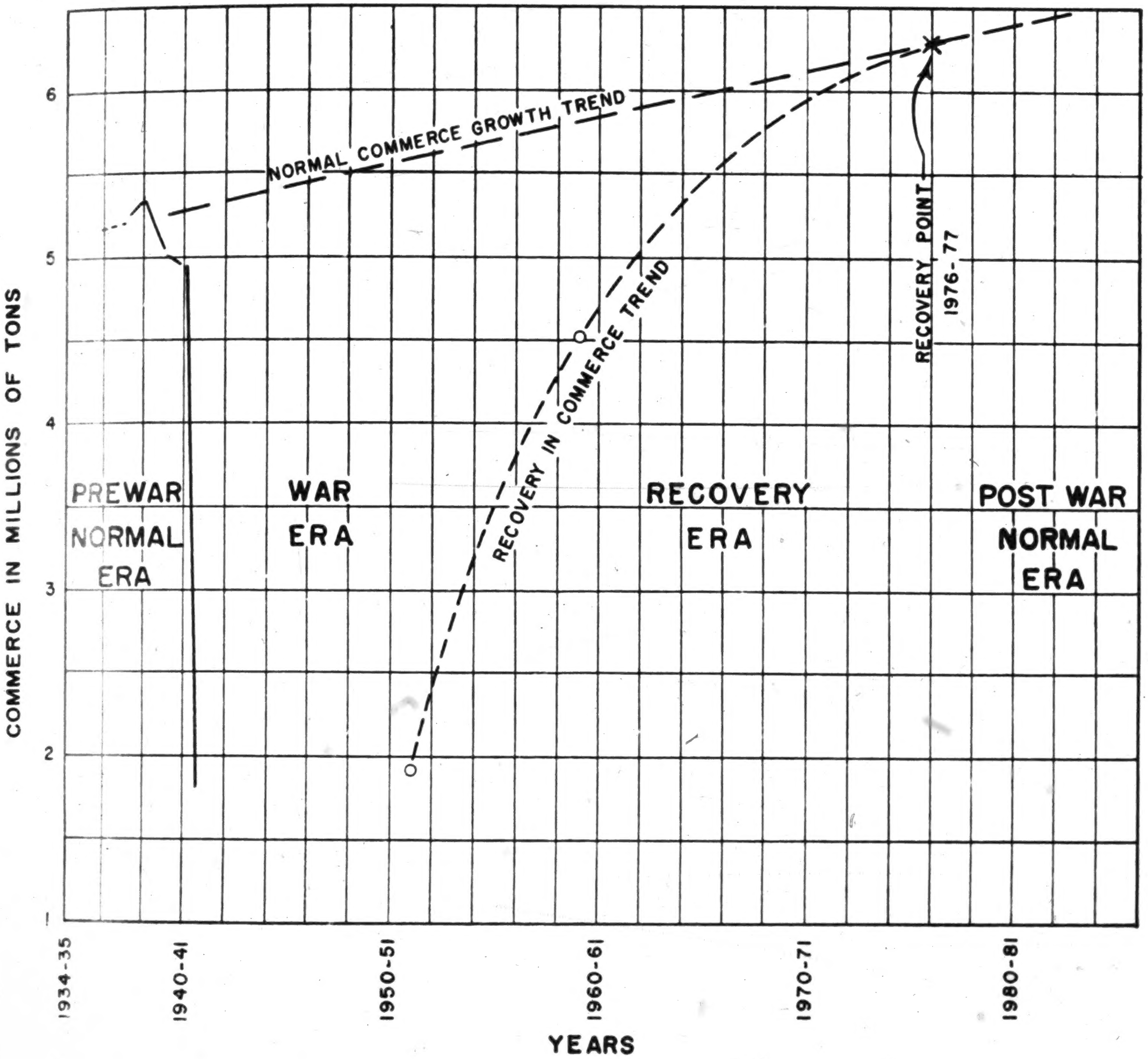
MINISTRY OF NATIONAL PLANNING

PORT OF RANGOON

ESTIMATED BREAK DOWN OF TOTAL FOREIGN COMMERCE

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. HRN
CK. BY. EJB
DATE MAY 53
PLATE NO 10



MINISTRY OF NATIONAL PLANNING

PORT OF RANGOON

ESTIMATED
TOTAL FOREIGN COMMERCE

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. CK. BY. HRN	DATE MAY 53	PLATE NO.	11

port 200,000 tons of Calcutta coal per year; and, that the demand in excess of the 200,000 tons will be furnished by charter ships until the operations at Kalewa are able to furnish the Rangoon deficiencies from the surplus over the demands of upper Burma.

The economic forecast of coastwise trade in the Port of Rangoon in fiscal year 1959–60 is 50,000 tons of imports and 150,000 tons of exports. These tonnages should be compared with the 40,500 tons of imports and 45,000 tons of exports in the past fiscal year 1951–52. The volume of riverine trade, in fiscal year 1951–52 was, as shown in Table XII–5, about 654,000 tons. At present the fleet of IWTB transports slightly more than 50% of its prewar tonnage and it is believed that the tonnage carried by privately owned river craft suffered a similar reduction. With the return of normal conditions, it is considered the riverine trade will reach and probably exceed the prewar level, and in fiscal year 1959–60 would be from 1,200,000 to 1,400,000 tons.

b. Improvement of Port Entrance

During the dry season, the bars in the Monkey Point Channel prevent the uninterrupted entrance to the port of vessels with a draft for which ample depth is available elsewhere in the harbor. The King's Bank Training Wall, constructed to effect a scouring action in the channel, has failed to achieve its purpose to the required extent and continuous dredging is required during the dry season to maintain only a depth of 14 to 16 ft. below Mean Low Water Springs datum. The regulation of tidal rivers generally presents very difficult and complex problems and there are numerous records of training walls and other regulation works built at great expense, only to be abandoned later and replaced by other structures. The conditions at Monkey Point Channel are further complicated because it lies at the confluence of the Rangoon River, Pegu River and Pazundaung Creek and is subject to silt deposition from each. It is possible that the construction of a training wall north of King's Bank Training Wall, of a training wall in Pegu River, or a combination of similar regulating works, will confine the flows over the bar to the extent necessary to produce scouring action of sufficient strength. However, no ready-made solution can be offered. On the other hand, the elimination or at least substantial reduction of Monkey Point bars is considered essential for improvement of port operations. It is believed that the means to achieve it could best be determined from a series of hydraulic model tests and it is recommended that the Commissioners engage the services of one of the recognized hydraulic laboratories in Europe or in the United States.

c. General-cargo Wharves

In the modern concept of design of general-cargo wharves the handling capacity assigned to a wharf 500 to 525 ft. long, accommodating a five-hatch ship, is 200,000 tons per year. This capacity is based on a handling rate of 25 tons per hatch per hour, on an eight-hour day, and on 200 working days per year. It is further predicated on a spacious transit shed, of approximately 92,500 sq. ft. area, and on complete mechanization of dockside cargo handling. The assumption of 200 working days a year, corresponding to 67% berth occupancy, has been found necessary to accommodate the uneven ship arrival and departure schedules, adverse weather conditions, labor and transport difficulties. The hourly rates of handling attained in various United States ports, where a large part of their commerce is composed of mixed general cargo similar to that of Rangoon, exceeded considerably the 25 tons per hatch per hour and rates of 30, 35 and 40 tons per hatch per hour are recorded. Even at the antiquated New York piers an average of 18 tons per hatch per hour are handled by gangs consisting of 17 to 20 stevedores. Whenever necessary, the daily rate of handling can be increased up to 100% by working two shifts per day.

The need for mechanization of dockside cargo handling in the Port of Rangoon becomes evident from the comparison of the number of wharves necessary for handling the future cargo volume when using present handling methods and when applying mechanical handling. In order to handle 1,820,000 tons in fiscal year 1959–60 nine wharves with an annual capacity of 200,000 tons each would be required. This demand could be satisfied by rebuilding Sule Pagoda Wharves Nos. 5, 6 and 7 and by introducing mechanization on all nine wharves. On the other hand, should even the prewar rate of approximately 700 tons per day be attained (at the cost of working the stevedores practically around the clock and having no margin for increase of daily rate of handling) 14 wharves would be required on the basis of 200 working days a year, or five new wharves would have to be built in addition to reconstructed Sule Pagoda Wharves Nos. 5, 6 and 7. As the cost of mechanization is extremely small in comparison with the cost of a wharf, mechanization of dockside cargo handling is the most economical solution.

At most of the sea ports in the United States where commerce consists of mixed general cargo similar to that handled in Rangoon, the type of handling equipment is basically the lift truck, pallets, tractors and trailers. The pallets are loaded in the ship's hold and are lowered to the wharf, there they are picked up by lift trucks and transported to the transit shed. When distances are greater than 300 feet, tractors and trailers are used for transport of pallets, or a combination of lift trucks with tractor-trailers. Mixed cargo is handled in small lots; steel racks with several shelves are often used in the transit sheds for storage of pallets. There is no set procedure. For determination of the number and types of equipment required in each particular case, detailed cargo routing and handling studies would be required.

Wharf cranes are not required for efficient cargo handling. They are not used in American ports, and all handling between ship and wharf is by ship's gear only. If wharf cranes are desired, there is no objection to their use, but it would be more advantageous to invest in more efficient handling equipment. If wharf cranes are obtained, then the lifting capacity should be not less than three tons and a modern type of crane used. The two-ton capacity cranes erected at the Brooking Street Wharves incorporate a level-luffing system based on multiple reeving of wire ropes. The disadvantages of this type of level-luffing system are widely recognized in continental European ports, and its use on new cranes is not accepted there. However, if the port decides to acquire additional new wharf cranes, then a more modern type should be selected, and consideration should be given to the "M.A.N." type which the French Commission for Standardization of Cargo Handling Equipment, after extensive research, adopted as the standard crane of three-ton capacity to be used in the rehabilitation of the French ports.

The 40-ton crane which is located at the west end of the Brooking Street Wharf No. 2 is installed in an unusual way with the tracks at right angles to the wharf face. Its field of action is therefore extremely limited. Furthermore, when the heavy load is in a hold out of the crane's reach, it often has been necessary, after discharge of the light cargo from the same hold, to take the ship out into the stream, turn it, and possibly to wait for the tide, in order to back up to the wharf. In addition, the location of the crane and rails prevents use of wharf area for cargo transit purposes, and obviates the enlargement and extension of the transit shed which will be necessary in obtaining an increased handling rate. Since the wharf is not designed for the movement of the 40-ton crane along the wharf face, and in view of the disadvantages of its present location, consideration should be given to its replacement by a floating crane of equal capacity, a crane which could serve all berths and could be used in salvage and other port operations. The present crane could be converted easily into a floating unit, or if desired, a new floating crane could be obtained and the present crane utilized beneficially at the existing marine yards or at the drydock recommended later in this report.

For design of general-cargo wharves in the Port of Rangoon a wharf capacity of 200,000 tons per year should be considered. This capacity is based on being able to achieve an average handling rate of 25 tons per hatch per hour or 1,000 tons per berth per shift of eight hours. For the needs in the immediate future the general cargo tonnage expected in fiscal year 1959–60 of 1,820,000 tons should be considered. This tonnage would require the nine wharves, which would be made available when the reconstruction of Sule Pagoda Wharves Nos. 5, 6 and 7 is completed. This requirement is in keeping with the Commissioners' seven-year program which provides for the initiation of the reconstruction of these three wharves in about 1954.

However, planning should not cease with the nine berths and additional berthing must be provided in orderly succession to have the facilities available when required by the demands of commerce. After the construction of Sule Pagoda Wharves Nos. 5, 6 and 7 has been completed, it would be prudent to continue immediately with Nos. 8, 9 and 10. Along the riverfront between Sule Pagoda Wharf No. 7 and Brooking Street No. 1 there is an ideal section of deep water which would permit three additional berths with lengths of about 500 feet each. Although parts of this area are subject to aesthetic restrictions, a suitable architectural and landscaping treatment could probably be developed that would satisfy the intent of the restrictions while accommodating the much-needed expansion of facilities.

With the construction of berths numbered 8, 9 and 10 there will be a continuous general-cargo section extending for 12 berths from Sule Pagoda No. 1 through Brooking Street No. 2. These wharves will be adequate for the estimated foreign general-cargo commerce up to fiscal year 1967–68. However, to accommodate the additional commerce by 1971–72 berth No. 13 will be needed and by 1978–79 berth No. 14 will be required. Berths numbered 13 and 14 can be provided in the section just east of Brooking Street Wharf No. 2; however, with the completion of these 14 berths for general cargo, full use has been made of the central deep-water section of the port. For commerce demands in excess of the capacities of these 14 berths a new general-cargo area may have to be established at other locations on the Rangoon River. The only other sections with favorable deep-water conditions are either at Ahlone or Kemmendine.

As previously indicated, in the modern concept of general-cargo wharf design a handling rate of 25 tons per hatch per hour is predicated on a spacious transit shed, with a floor area of about 92,500 sq. ft., or a shed approximately 420 ft. by 220 ft. Sheds of these dimensions could be built on all newly constructed wharves, except at Brooking Street berth No. 4, where the shed would be 340 ft. by 220 ft. The total area of the transit sheds presently existing at the six wharves amounts to 303,500 sq. ft. or an average of only 50,583 sq. ft. per shed. With full mechanization this area would accommodate a handling rate of not more than about 14 tons per hatch per hour. It is therefore proposed to enlarge the existing sheds as shown in the following tabulation:

Berth	*Present*		*Proposed*	
	Size (ft.)	*Area (sq. ft.)*	*Size (ft.)*	*Area (sq. ft.)*
Sule Pagoda Wharves				
Berth No. 1	360 × 150	54,000	360 × 240	86,400
,, ,, 2	380 × 150	57,000	380 × 240	91,200
,, ,, 3	340 × 125	42,500	370 × 240	88,800
,, ,, 4	420 × 150	63,000	420 × 220	92,400
Brooking Street Wharves				
Berth No. 1	240 × 150	36,000	420 × 220	92,400
,, ,, 2	340 × 150	51,000	340 × 220	74,800
		303,500		526,000

The additional 222,500 sq. ft. represent an increase of 73·5%. The total provided transit-shed area of 526,000 sq. ft. corresponds to an average of 87,667 sq. ft. per shed and it is estimated that this area would permit the attainment of a handling rate of approximately 23·8 tons per hatch per hour. Thus, with full mechanization of cargo handling, the six existing berths with enlarged sheds could handle in 200 shifts of eight hours each about 1,142,000 tons annually. With berths 5, 6 and 7 in operation the handling capacity of the nine berths would amount to about 1,742,000 tons per year, which is approximately the volume of the commerce to be expected in fiscal year 1958–59. For the following years the required transit-shed capacity would be:

Period (fiscal year)	*Gen. Cargo to be Handled (tons)*	*Capacity of Wharves (tons)*	*Area of Sheds (sq. ft.)*	*Capacity of Sheds (tons)*	*Number of Sheds*
1958–59	1,720,000	1,800,000	803,200	1,742,000	9
1960–61	1,915,000	2,000,000	895,600	1,942,000	10
1962–63	2,090,000	2,200,000	988,000	2,142,000	11
1965–66	2,305,000	2,400,000	1,080,400	2,342,000	12
1969–70	2,515,000	2,600,000	1,172,800	2,542,000	13
1974–75	2,700,000	2,800,000	1,247,600	2,704,000	14

Due to the fact that space limitations prevent the enlargement of transit sheds at Sule Pagoda Nos. 1, 2 and 3 and Brooking Street No. 2 to required dimensions the average capacity of the transit sheds is less than 200,000 tons per year, which is the assumed capacity of a berth. Therefore, the availability of required transit-shed facilities would control the total annual handling capacity. The above tabulation indicates that berths Nos. 9 to 14 should be ready for operation in the years 1958, 1960, 1962, 1965, 1969 and 1974 respectively. However, the reconstruction of the existing transit sheds cannot be started until replacements are available or until the Sule Pagoda Transit Sheds Nos. 5, 6 and 7 are in operation, and the construction program should be planned accordingly. The locations of the aforementioned features are shown on Plate 4 entitled "Proposed General Cargo Wharves."

In the design of a modern general-cargo port it is customary to provide storage capacity equal to at least 50 to 75% of the transit capacity. It is considered that in the Port of Rangoon, with the bulk of the sea-going commerce of foreign source and destination, it would be prudent to provide a storage area of 65 to 70% of transit-shed area, or about 850,000 sq. ft. The wharf area is very restricted in width, being less than 500 ft. wide at the Sule Pagoda Wharves Nos. 1 to 7. Therefore it is proposed to provide second-story warehouses over all transit sheds with the exception of Sule Pagoda Shed No. 4. The enlargement of this transit shed is only 70 ft. (from 150 ft. to 220 ft.), and it is considered that this width is not enough for an adequate warehouse. The widths of the second-story warehouses are 90 ft. over Transit Sheds Nos. 1 and 2, 115 ft. over Transit Shed No. 3, and 100 ft. over all other transit sheds. In addition to these 13 second-story warehouses there are provided five ground-floor warehouses in back of the Sule Pagoda Transit Sheds Nos. 4, 5, 6, 7 and 10 and three warehouses in back of the Brooking Street Transit Sheds Nos. 1, 3 and 4. The dimensions of five of these ground-floor warehouses are 420 ft. by 100 ft.; the dimensions of three others vary from 320 ft. by 100 ft. to 500 ft. by 100 ft. depending on available space. The total floor area of all 21 warehouses is about 853,000 sq. ft. In addition to the warehouses ample open storage areas are provided. The locations of both the existing and proposed transit sheds and warehouses are as shown on Plate 4.

It is proposed to modify the existing railway and road layout to provide each warehouse and transit shed with sufficient railway trackage and with adequate road access. All wharf areas should be properly surfaced to permit the full development of cargo-handling operations. To provide the connection between the rail tracks in the area of Brooking Street Wharves and those in the area of Sule Pagoda Wharves it is proposed to extend the west end of the

Brooking Street Wharf by about 150 ft. at an early stage of the construction program. At a later stage this extension would be connected to Sule Pagoda Wharf No. 10.

Assuming that the development of the foreign commerce in the Port of Rangoon will follow approximately the forecast trend, the provision of new facilities for handling of general cargo would require a construction program practically continuous over the next 20 years. The construction could be accomplished in the five following stages:

Stage I. (To be ready for operation by 1958.)

(1) Mechanize immediately as much as possible the transit sheds at Sule Pagoda berths Nos. 1, 2, 3 and 4 and Brooking Street berths Nos. 1 and 2.

(2) Construct Sule Pagoda Wharves Nos. 5, 6 and 7.

(3) Construct transit-shed-warehouse structures and back warehouses at S.P. berths Nos. 5, 6 and 7.

(4) Mechanize fully S.P. berths Nos. 5, 6 and 7.

(5) Enlarge transit-sheds at S.P. berths Nos. 1, 2, 3 and 4 and add warehouses as second story at 1, 2 and 3.

(6) Construct back warehouse at S.P. berth No. 4.

(7) Remove 40-ton crane and convert to floating unit.

(8) Extend B.S. Wharf No. 1 about 150 ft. westward.

(9) Enlarge transit sheds at B.S. berths Nos. 1 and 2 and add warehouses as second story on both structures.

(10) Construct back warehouse at B.S. berth No. 1.

(11) Construct rail and highway access facilities.

(12) Complete mechanization at transit sheds for S.P. berths Nos. 1, 2, 3 and 4 and B.S. berths Nos. 1 and 2.

Stage II. (Berth No. 8 to be ready for operation by 1960; No. 9 by 1962.)

(1) Move passenger accommodations to Lanmadaw foreshore just west of S.P. Wharf No. 1.

(2) Construct S.P. Wharf No. 8 before 1960 and No. 9 before 1962.

(3) Construct transit-shed-warehouse structures No. 8 before 1960 and No. 9 before 1962.

(4) Construct rail and highway access facilities.

(5) Mechanize transit sheds and warehouses.

Stage III. (To be ready for operation by 1965.)

(1) Construct S.P. Wharf No. 10.

(2) Construct transit-shed-warehouse structure and back warehouse at S.P. berth No. 10.

(3) Construct rail and highway access facilities.

(4) Mechanize transit shed and warehouses.

Stage IV. (To be ready for operation by 1969.)

(1) Construct Brooking Street Wharf No. 3.

(2) Construct transit-shed-warehouse structure and back warehouse at B.S. berth No. 3.

(3) Construct rail and highway access facilities.

(4) Mechanize transit shed and warehouses.

Stage V. (To be ready for operation by 1974.)

(1) Construct B.S. Wharf No. 4.

(2) Construct transit-shed-warehouse structure and back warehouse at B.S. berth No. 4.

(3) Construct rail and highway access facilities.

(4) Mechanize transit shed and warehouses.

There are preliminary measures which should be undertaken by the Commissioners as soon as possible in the endeavor to increase the rate of cargo handling even before the mechanization program is effected. The Customs services should be studied closely, to determine procedures for reducing the required paper work and to expedite all cargo clearance operations. The lockfasts should be removed from the transit sheds to increase the area for cargo handling. The main reasons for lockfasts in the transit sheds are the requirement for protection against pilferage and the possible objections of insurance companies against removal of cargo from transit sheds prior to settlement of claims. Both objections can be eliminated easily by providing the same protections against pilferage for the goods outside transit sheds as inside, and by assigning to the port a sufficient number of insurance appraisers.

The advantage of daily pay as against monthly pay of the dock labor of the Commissioners' Traffic Department should be reconsidered in the light of obtaining more able and efficient personnel. Consideration should be given to increasing the demurrage rates considerably to accelerate the movement of cargo. A program of educating the trade unions of port workers should be undertaken immediately in the attempt to increase the rate of handling, for economics in port operation in Rangoon directly affect the economy of Burma as a whole.

d. Foreshores

It is estimated that the Lanmadaw and Botataung foreshores would handle about 80% of the total traffic at all foreshores, or about 1,000,000 to 1,200,000 tons annually. To prepare the embankments for efficient handling of larger volumes of cargo it is proposed to increase the berthing and storage facilities, to improve the access roads and railway connections and to introduce the mechanical transport of cargo to and from storage. The main improvement of the Lanmadaw foreshore would consist of the construction of a retaining wall along its entire length, thus straightening the foreshore alignment and increasing substantially the foreshore area. The details of proposed improvements are shown on Plates 3 and 4 entitled "Suggested Reconstruction—Lanmadaw Foreshore" and "Suggested Reconstruction—Botataung Foreshore."

(1) Lanmadaw Foreshore

The improvements recommended for this foreshore under the over-all development plan include modifications to the foreshore, the pontoon jetties, and the warehouses. Foreshore modifications would include the construction of a pile-supported reinforced-concrete stepped retaining wall about 5,200 ft. long, extending from Sule Pagoda Wharf No. 1 to Ywathit Creek and along the left bank of the creek. The fill between the retaining wall and the existing foreshore would add from 20 ft. to 170 ft. to the foreshore width and about 400,000 sq. ft. to its area. The jetty modifications would include the progressive replacement of the existing 16 pontoons which have a total berthing space of about 2,100 ft. with 16 pontoons dimensioned 30 ft. by 200 ft., with two bridges each, with a total berthing space of 3,200 ft. The berthing space will be thus increased by about 50%. Warehouse modifications would include reconstruction and replacement of existing sheds and godowns (with a total area of 363,700 sq. ft.) with new warehouses and open storages having a total area of 643,000 sq. ft. The storage area thus will be increased by about 77%.

For preliminary cost estimates it is assumed that the existing warehouse space would be increased by about 50% to 540,000 sq. ft. and the balance of the newly provided area, or 103,000 sq. ft., would be open storage. Reconstruction is recommended of the existing roads and the construction of new roads to provide a 90-ft. to 100-ft. wide road along the foreshore, 50-ft. wide roads between the warehouses, a 100-ft. wide access road at the Morton Street gate and correspondingly wide accesses at other gates. The pavement of the entire area of the foreshore not occupied by storage will permit the use of tractors and trailers for transport of goods from warehouses to jetties. Modifications and extension of the existing railway layout will be required to provide two railway tracks along the embankment and railway sidings at each warehouse. It will be necessary to provide mechanization of cargo transport to and from the warehouses. In view of the existing space limitations of the Lanmadaw foreshore consideration should be given to a special treatment of living quarters, recreation areas and parks to insure full availability of the needed working areas.

At the Lanmadaw foreshore the construction of the retaining wall and of the new warehouses, the installation of the new pontoons and other required improvements should proceed in such a way as not to interfere with the already congested traffic. It is therefore suggested to begin the construction at Ywathit Creek and then proceed eastward along the foreshore. It is assumed that with the start of shipping of export rice from Ahlone Wharf the use by SAMB of the Keighley Street pontoons No. 1 and 2 could be discontinued. This would permit the construction of 800 to 1,000 ft. of retaining wall, the installation of new pontoons Nos. 1 to 3, and the construction of Warehouses A to E. Then the berthing of craft using Keighley Street No. 3 and William Street pontoons could be transferred to new pontoons, thus allowing the progressive construction of an additional section of retaining wall. In that manner the entire new foreshore could be built, section by section.

(2) Botataung Foreshore

The improvements recommended for this foreshore under the over-all development plan include extension of the foreshore, the installation of additional pontoon jetties, and the reconstruction and modification of the warehouses. Extension of the foreshore should be made west to the boundary of the storeyard of the Commissioners. With the organization of a central coal depot at the new coal wharf, as described later in this chapter, the present coal yards of the Burma Railways and the Coal and Coke Agency can be eliminated and these areas turned to the use of the Commissioners. It is proposed to transfer the stores of the Commissioners' chief engineer to one of these areas, preferably to that of the railway coal yard, adjacent to Commissioners' Work Shops. This would permit the use of Botataung Jetty No. 2 by river-borne commerce, now used exclusively for the chief engineer's stores; and it would also allow the construction of Warehouse A.

Installation of additional pontoons and jetties should be accomplished. There are at present five pontoons at the Botataung foreshore, three of which are sized 40 ft. by 200 ft. It is proposed to install four additional pontoons 40 ft. by 200 ft., thus increasing the total number of pontoons to seven and the berthing space to 1,400 ft., an increase of nearly 100% over the present berthing space of about 720 ft. There should be constructed new warehouses with a total area of about 307,000 sq. ft., replacing the existing warehouses having an area of about 214,700 sq. ft. The increase of storage area will be about 43%. The access roads should be relocated and the areas around the warehouses paved. Relocation of railway tracks will be required and provision made for railway sidings at each warehouse and for connections to a track along the embankment. It will be necessary to provide mechanization of cargo transport to and from the warehouses.

The reconstruction of the foreshores should start as soon as Ahlone Wharf No. 1 is in full operation, thus taking away from the foreshores a part of the export rice trade. It is advisable to start first with the improvement of the Botataung foreshore, as the construction work there would interfere least with cargo-handling operations. The improvement could start with the installation of the additional pontoon jetties.

The construction of warehouses could be conveniently started with Warehouses A and B. After their completion and the goods have been transferred from the old warehouses, the latter could be removed progressively and replaced by the new ones. As the future development of inland exports requires additional storage space, Warehouses B, C and D could be extended as shown in dotted lines on Plate 4 entitled "Suggested Reconstruction—Botataung Foreshore." This extension would provide an additional 75,000 sq. ft. of storage area. However, the lengthening of these three warehouses would necessitate prior removal of living quarters of the Port Police to a new location outside the port boundaries and demolition of the present quarters between Strand Road and Hoppers Road.

e. Rice Export Wharves

At present, rice is delivered in lighters to the ship's side in midstream. These lighters either originate at the mills with delivery phased to coincide with ship arrival, or are loaded at the various sites of storage in the port and adjacent areas. As previously indicated, about 40 to 45% of the present annual rice export is by lighterage of the first category and the bulk of the remaining rice is lightered later from warehouse to ship. If the procedure of loading with mechanical equipment at dockside could be obtained for at least the export cargo which has been stored, then the expensive and slow lighterage could be eliminated on 55 to 60% of the export rice. In this direction, the Commissioners for the Port of Rangoon have assigned temporarily to the State Agricultural Marketing Board the use of the present Ahlone Wharf (No. 1). Until now only a few ships have been loaded at dockside, but the limited experience already obtained has shown that the rate of loading in that manner, even though by coolie labor, was about double that obtained when loading a ship in midstream from lighters.

The lift-truck system of mechanized handling, using pallets, lends itself well to such commodities as bagged rice. In various rice-loading ports in the United States and where other bagged goods are handled, rates of handling are obtained which vary up to 30 and 45 tons per hatch per hour and some have realized up to 60 tons. It would be reasonable to assume that use of similar equipment at the Port of Rangoon would produce rates up to 30 tons per hatch per hour. With five hatches working, the rate of loading a ship in an eight-hour day would be 1,200 tons or 240,000 tons in 200 working days per year. This rate could be increased whenever necessary up to 100% by working two shifts. Since during four to five months per year the volume of export is considerably over the average, it may be assumed safely that a single berth with adequate transit accommodations and mechanical handling equipment would be in excess of 300,000 tons per year.

When using the pallet and lift-truck system, the rice bags could be loaded at railway car or truck onto pallets, transported to the transit shed either by lift truck or trailer and tractor, stacked by lift truck, transported to dockside either by lift truck or trailer, and thence loaded into the ship's hold where it would be unloaded by hand. The only times the bags are manhandled would be at railway car or truck on arrival from dead storage and unloading in the hold. To realize the maximum benefits would require the establishment of a definite traffic-flow pattern, which must be followed, and an adequate supply of equipment and operators.

In comparing the pallet system with mechanical conveyors, it is to be noted that the bags have to be loaded by hand on conveyors, removed by hand from the upper end of conveyor for stacking and removed by hand from storage, for transport to ship's side. It will be difficult to maintain in these conditions a steady flow of cargo, which is the prerequisite of efficient and economical operations. It is of interest to note that the conveyors were tried and rejected in rice-exporting ports of the United States, which now use only the fork-lift truck system.

(1) Ahlone Wharf No. 1

The existing Ahlone Wharf (No. 1), well situated on deep water with three transit sheds served by railway and road close to the wharf, should continue to be used as a rice export depot. However, the sheds must be used for transit only and dead or long-time storage must be at other locations so as not to interfere with other scheduled port operations. The present sheds have an area of about 90,000 sq. ft. and with mechanical equipment would be able to furnish 60 to 65% of that area for stacking. This would provide transit storage for 10,000 to 12,000 tons, which would be adequate for two full ship loads. The minimum amount of rice to be moved over this wharf should be held at 300,000 tons.

Certain modifications and improvements should be made as soon as possible at Ahlone Wharf No. 1 to condition it for the rice trade. The three timber ramps extending between sheds and wharf should be removed, the area filled in with a pile-supported concrete deck, and the present wharf strengthened. The areas around the sheds should be paved. The present railway and highway facilities will require improvements to permit delivery of about 2,400 tons per day. The recommended improvements are shown on Plate 7 entitled "Proposed Rice Wharves."

(2) Ahlone Wharf No. 2

When the volume of rice export tonnage approaches the prewar level a second wharf should be provided for rice handling. The Commissioners have available immediately downstream of Ahlone Wharf No. 1 a strip 500 ft. in length; beyond that, the land is leased by the Commissioners to the State Timber Board. The frontage of 500 ft. will be sufficient for an additional berth; however, the width restricts railway approach and two transit sheds would be required. The new Ahlone Wharf No. 2 should be a marginal type, 500 feet in length, and abutting on No. 1 to provide a continuous deck surface. The wharf apron should be 50 to 60 ft. wide and two transit sheds, each 175 ft. by 250 ft., constructed. Railway sidings and paved areas should be provided as required to serve adequately all access needs. The schematic layout of Wharf No. 2 is as shown on Plate 7.

f. Coal Import Wharf

As shown previously in this report there is an urgent need of facilities to unload the coal ships mechanically and this requirement can best be satisfied through the installation of a coal wharf with a mechanical coal-unloading bridge. A detailed analysis was made of this problem in a project report and the data included herein is summarized from that report. This wharf would eliminate costly lighterage, increase the handling rate with consequent reduction in handling costs, reduce the turn-around time of the coal vessels, and concentrate the trade in one depot instead of the three major ones presently used.

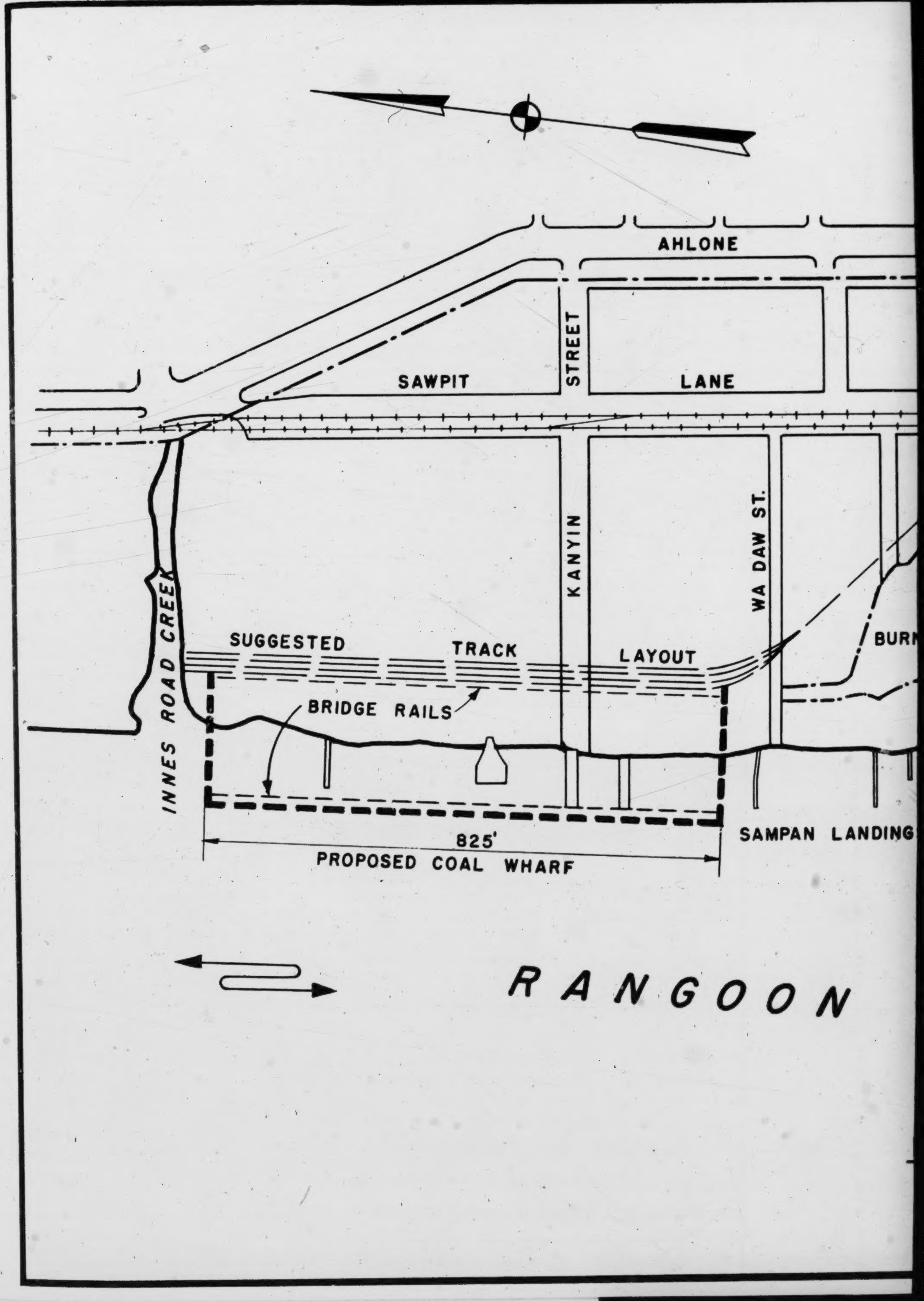
The coal wharf should be in one of the deep-water sections of the port, should have adequate railway and highway access, should be in an area where coal dust would not be troublesome, and preferably should be as near as possible to the rice-handling wharves since the same Government of the Union of Burma Shipping Board vessels bringing coal would be used in the rice export trade. The site that best fulfills all of the above criteria is on the left bank of the upper Rangoon River, immediately upstream of the Ahlone rice wharves and the Hindu Burning Ghat. The site should incorporate the area from the Ghat upstream to the Innes Road creek. This entire reach, representing a frontage of about 950 to 1,000 ft., should be reserved for coal-handling facilities.

The wharf should be of the marginal type. It should have a small shipside apron, about 12 to 15 ft. wide, and an adequate support for the rails of the coal-unloading bridge. A concrete sheet-pile retaining wall should be incorporated with the apron and riverside bridge rail supports. Concrete sheet-pile retaining walls also would inclose the wharf ends. The minimum length of the wharf should be not less than the berthing requirements of one collier; however, the storage-area requirements would fix the actual dimensions. Considering that a storage of a three-month demand should be provided, the fiscal year 1959–60 demand would be for approximately 75,000 to 80,000 tons. With base width of the stockpile of 190–195 ft., the required length of wharf necessary to provide storage for about 75,000 to 80,000 tons would be 825 ft.

The coal-handling bridge would have a span of about 200 ft. and would travel over the full length of the wharf. At the river side the bridge would have a raisable section so as to clear the vessels when they are maneuvering at the wharf. At the land side the bridge would have a cantilever reaching over the railway tracks. A bin with a capacity of about 60 tons could be installed at the land-side leg, equipped with gates for loading of cars and trucks. The bucket would have a capacity of about five tons of coal. It was estimated that this bridge would handle about 1,500 tons of coal in an eight-hour shift, or 3,000 tons per day of two shifts when unloading the ships; however, in rehandling about 75% of the storage while loading in railways cars and trucks the bridge would operate at about two thirds of this rate, or approximately 1,000 tons per shift. Thus, for a commerce of about 300,000 tons, the bridge would be used 200 shifts in unloading and 225 shifts in rehandling. The pertinent data regarding the proposed coal-handling depot are shown on Plate 12 entitled "Proposed Coal Wharf."

g. Marine Repair and Dry-docking

Dry-docking facilities are a necessary element of ship-repair installations of a properly appointed port. In most of the world ports, with the volume of traffic comparable to that of the Port of Rangoon in the prewar period, the available dry docks are of a size sufficient to accommodate nearly all types of vessels calling at the port. However, the geographical location of Rangoon and the proximity of dry docks at Calcutta and Singapore practically excluded the demand for dry-docking of larger vessels in the Port of Rangoon. The marine slipways available at the boatyards and work shops operated by the various government agencies, as well as the only existing privately owned dry dock in the Port of Rangoon, all have a limited capacity and were provided originally to serve the harbor craft of the Commissioners for the Port of Rangoon, the vessels of the Mercantile Marine De-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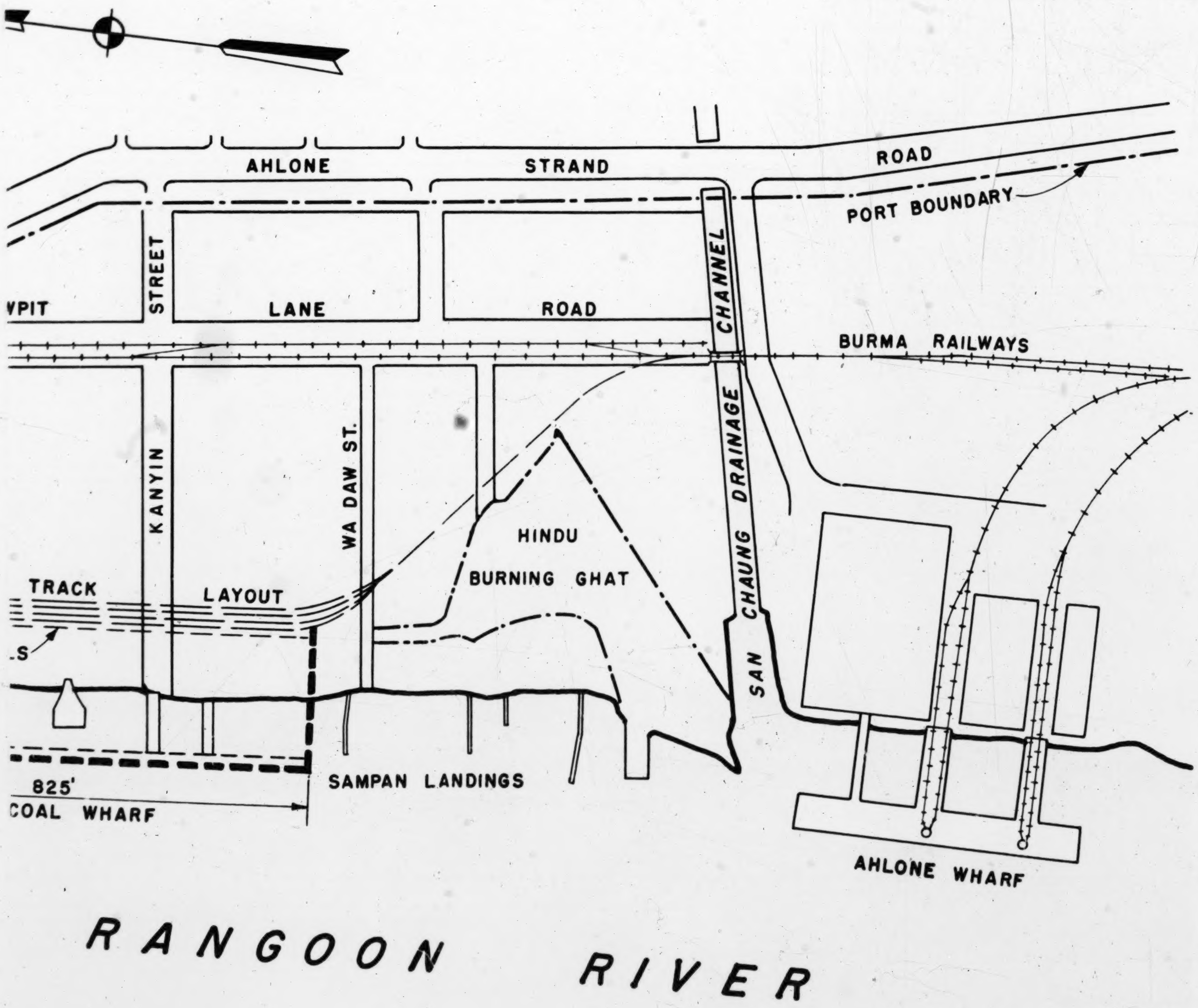
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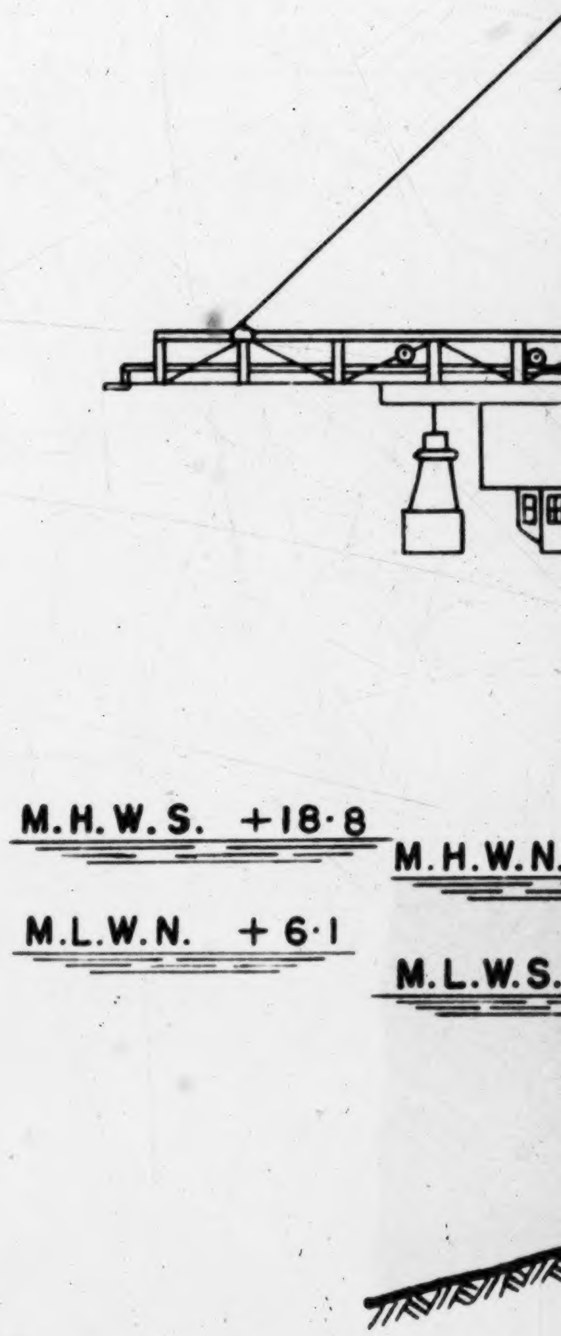
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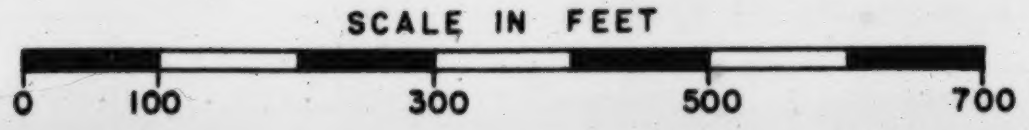
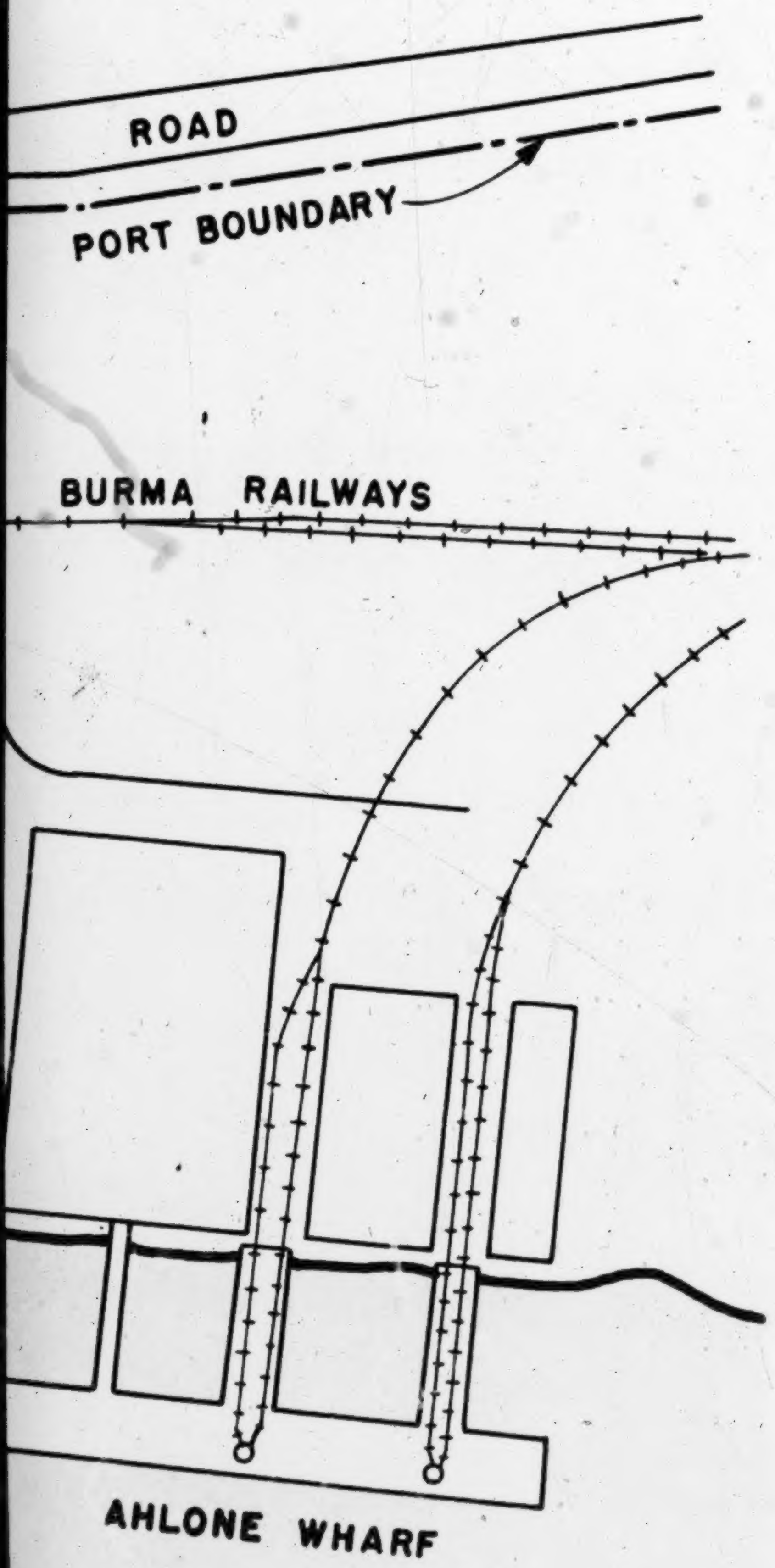
M.L.W.N. +6·1
M.L.W.S.

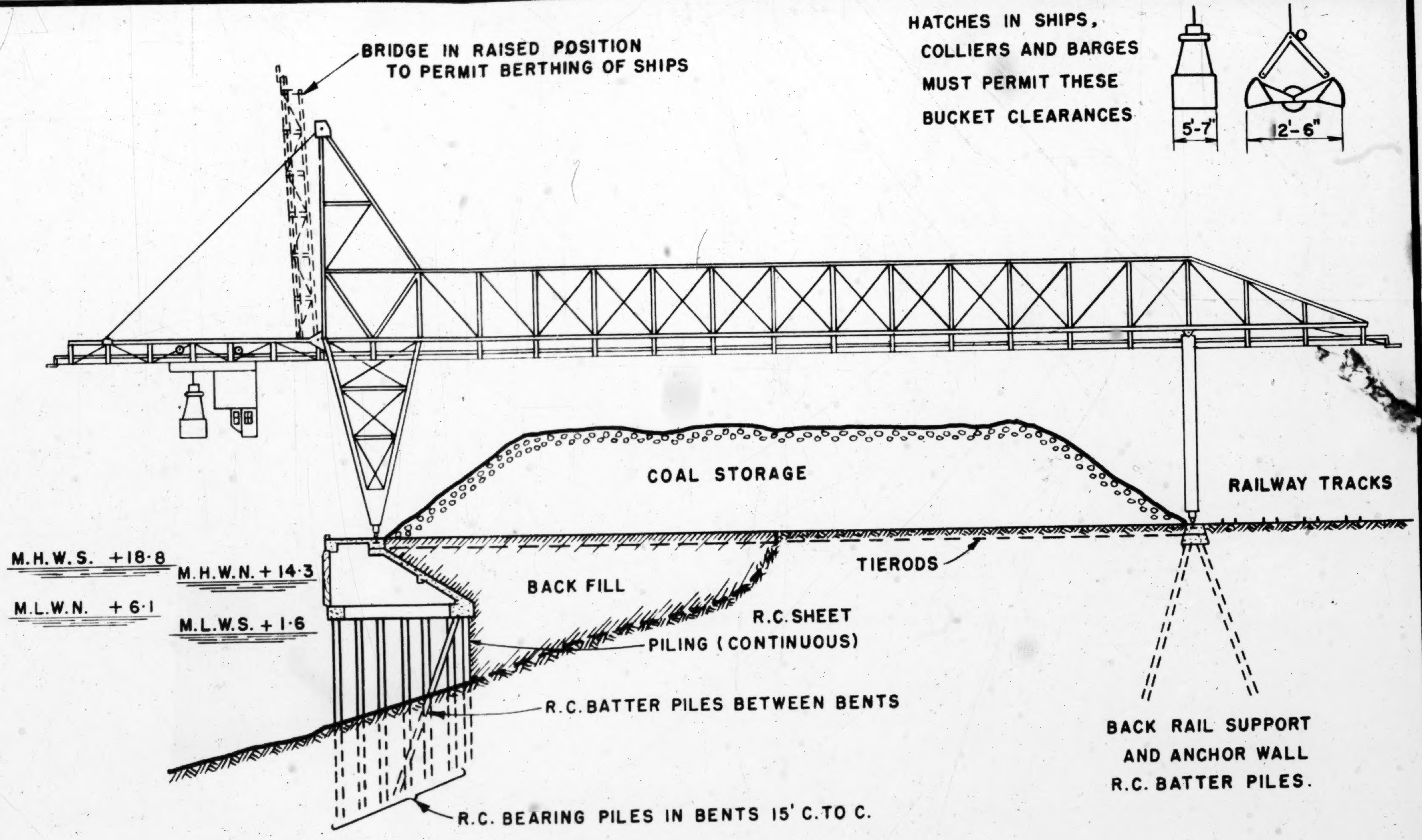
PLAN OF PROPOSED COAL WHARF


SCALE IN FEET
0
100
300
500
700


ROAD
PORT BOUNDARY
BURMA RAILWAYS
AHLONE WHARF

ED COAL WHARF

ET
500 700


BRIDGE IN RAISED POSITION TO PERMIT BERTHING OF SHIPS
5'-7"
12'-6"
COAL STORAGE
RAILWAY TRACKS
M.H.W.S. +18·8
M.H.W.N. + 14·3
M.L.W.N. +6·1
M.L.W.S. + 1·6
TIERODS
BACK FILL
R.C. SHEET PILING (CONTINUOUS)
R.C. BATTER PILES BETWEEN BENTS
BACK RAIL SUPPORT AND ANCHOR WALL R.C. BATTER PILES.
R.C. BEARING PILES IN BENTS 15' C. TO C.

HATCHES IN SHIPS,
COLLIERS AND BARGES
MUST PERMIT THESE
BUCKET CLEARANCES

SECTION THROUGH PROPOSED WHARF

SCALE IN FEET
0 20 40 60 80 100

NOTE:-

TYPICAL SECTION USED FOR COSTING ONLY, NOT BASED ON DETAILED DESIGN AS REQUIRED FOR CONSTRUCTION.

MINISTRY OF NATIONAL PLANNING

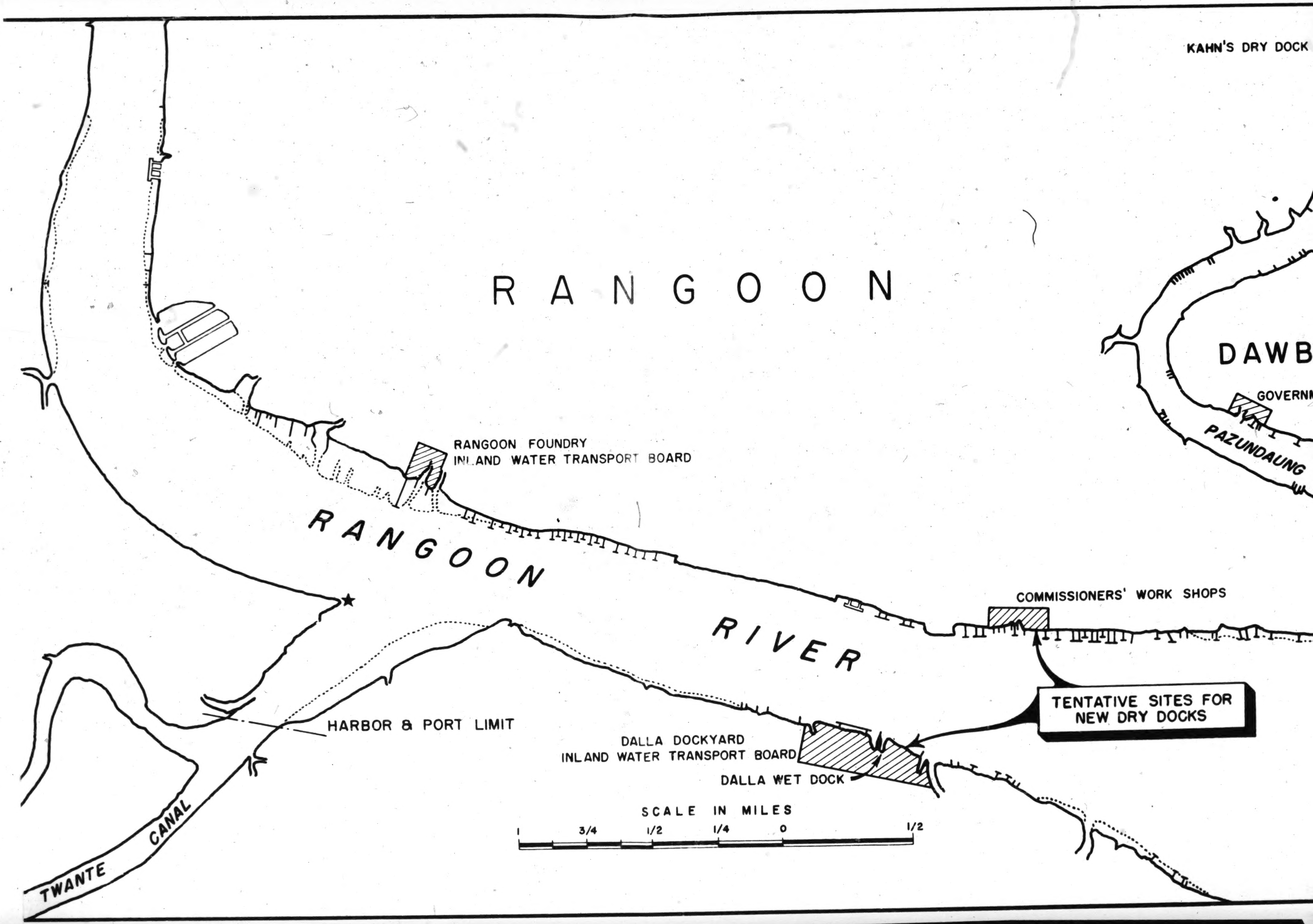
PORT OF RANGOON

PROPOSED COAL WHARF

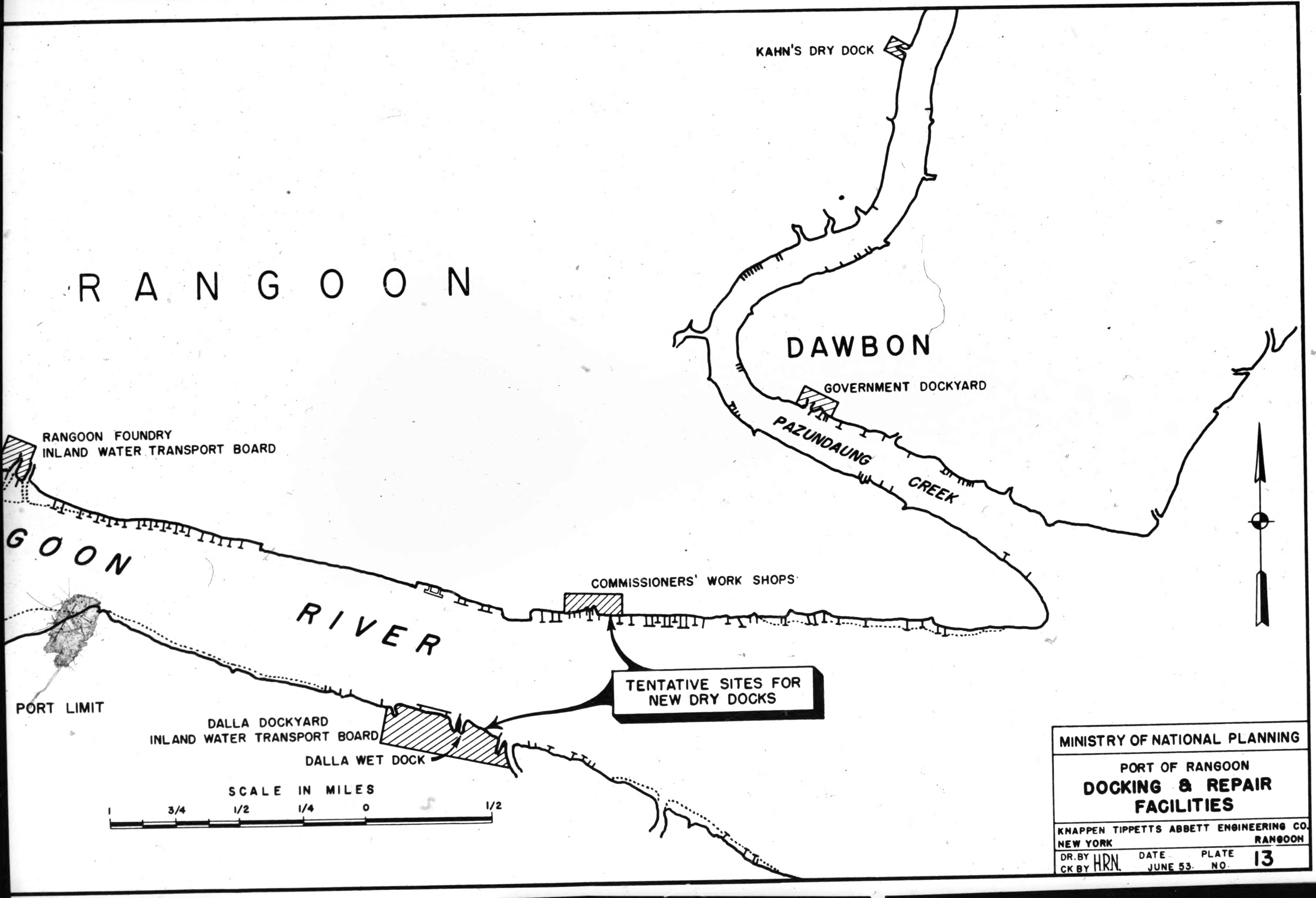
KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. HRN DATE PLATE
CK. BY. CP MAY, 53. NO. 12

KANAUNGTO
CREEK
TWANTE



KAHN'S DRY DOCK
RANGOON
DAWB
GOVERNM
PAZUNDAUNG
RANGOON FOUNDRY
INLAND WATER TRANSPORT BOARD
RANGOON RIVER
COMMISSIONERS' WORK SHOPS
TENTATIVE SITES FOR NEW DRY DOCKS
HARBOR & PORT LIMIT
DALLA DOCKYARD
INLAND WATER TRANSPORT BOARD
DALLA WET DOCK
SCALE IN MILES
1
3/4
1/2
1/4
0
1/2
TWANTE CANAL


KAHN'S DRY DOCK
RANGOON
DAWBON
GOVERNMENT DOCKYARD
PAZUNDAUNG CREEK
RANGOON FOUNDRY
INLAND WATER TRANSPORT BOARD
GOON
RIVER
COMMISSIONERS' WORK SHOPS
TENTATIVE SITES FOR NEW DRY DOCKS
PORT LIMIT
DALLA DOCKYARD
INLAND WATER TRANSPORT BOARD
DALLA WET DOCK
SCALE IN MILES
1
3/4
1/2
1/4
0
1/2

MINISTRY OF NATIONAL PLANNING

PORT OF RANGOON

DOCKING & REPAIR FACILITIES

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY
CK BY H.R.N. DATE JUNE 53. PLATE NO. 13

partment, the fleet of Inland Water Transport Board and other government-owned craft.

According to the records of the Nautical Adviser, as of September 1951, there were in Burma 51 vessels varying in length from 110 to 340 ft., all of which should normally be docked at least once a year. Of these, 46 were small ships which could have entered Kahn's dock when breadth and length of vessel was considered; but, as mentioned previously, due to restrictive sill conditions, only 14 of the 46 craft could use the dock. Since then the Union of Burma Shipping Board has been established. It already has placed in service the S.S. *Pyidawtha*, a vessel about 245 ft. long with a 39-ft. beam, plying between Rangoon and the Arakan outports of Akyab, Kyaukpyu and Sandoway. Orders have been placed for two additional coastal vessels of similar dimensions. Four vessels are contemplated for the India rice-coal trade. These will be about 425 ft. in length, with freshwater draft loaded not over 23 ft. Two of these vessels are under construction and scheduled for delivery in April and August 1954. None of these vessels could use Kahn's Dry Dock.

In consideration of an annual docking time of 10 to 12 days per vessel, it would appear that the 51 vessels as of September 1951, plus seven vessels of the Union of Burma Shipping Board, would require about 580 to 700 docking days per year. Considering the impending augmentation of various fleets, such as of the harbor craft of the Commissioners for the Port of Rangoon, of the Burma Navy and others, it would be reasonable to consider a requirement in the immediate future of not less than 800 docking days. Out of the total number of vessels to be docked annually in Rangoon, there were in September 1951 five vessels too large to enter Kahn's Dry Dock. In the same category would fall the seven ships of the Union of Burma Shipping Board, the Burma Navy vessels of the "Mayu" class or larger, and a certain number of the larger types of private vessels. Considering the cumulative repair needs of all these vessels, it appears evident that adequate dry-docking facilities should be provided for them at an early date at the Port of Rangoon (see Plate 13).

Summarizing the above data, it can be concluded that the total required dry-dock capacity in the Port of Rangoon could be supplied by two small dry docks —approximately of the same size as Kahn's Dry Dock—and by one larger dry dock. The latter must be of a size sufficient to accommodate government vessels up to 425 ft. in length and 8,000 dead-weight tons and the privately owned vessels of the Liberty and the T-2 Tanker classes, or vessels up to about 525 ft. in length, 68 ft. breadth and dead-weight tonnage of approximately 17,000 tons. Preliminary investigations indicate that one of the additional small dry docks required in the Port of Rangoon could be obtained relatively quickly and at low capital investment by the conversion of the existing wet dock at the Dalla Dockyard of the Inland Water Transport Board into a small dry dock. Kahn's Dry Dock would continue to serve as a second unit. The third unit, a dock capable of accommodating larger vessels, must be a completely new installation.

(1) Improvement of Kahn's Dry Dock

Preliminary inspection of Kahn's Dry Dock indicated that the structure is in a fair condition. However, a substantial improvement of its efficiency by means of minor alterations does not appear practicable. The height of the sill is only about three feet. Thus, the possible lowering of the sill by one foot or 1·5 feet, and the concurrent rebuilding of gates, would not materially improve the entrance conditions. Any reconstruction for the purpose of a substantial lowering of the sill or of an increase in horizontal dimensions would require practically complete demolition of the existing structure and the construction of an entirely new dock. However, Pazundaung Creek should be eliminated as a location of new docking facilities. Therefore, no major changes of Kahn's Dry Dock are recommended and the only improvements suggested are those of the unwatering system and other general rehabilitation measures. An additional disadvantage of Kahn's Dry Dock is the lack of any repair-shop facilities. The repair of dry-docked ships would have to be done at the shops of the Government Dockyard at Dawbon, on the opposite bank of and downstream along Pazundaung Creek. In view of other limitations of Kahn's Dry Dock, it appears that costly shop installations there would not be warranted. If Kahn's Dry Dock is used for service of shallow-draft vessels it would fit well into a general docking plan for the Port of Rangoon.

(2) Reconstruction of Wet Dock at Dalla Dockyard

From preliminary inspection and analysis it appears that, with the construction of an entrance-gate bay, the wet dock could be converted economically into a suitable dry dock, retaining approximately the same draft and horizontal clearances. New walls and floor also may be required, depending on the results of soil explorations and tests and of detailed engineering investigations. This dock would be of prime importance because of its location on the Rangoon River and its nearness to up-to-date shops and marine repair facilities. Its main disadvantage would continue to be the high elevation of the sill. The reconstruction of the Dalla Wet Dock could be started immediately and the period of reconstruction would depend mainly on the design, delivery period of the gate and construction of the entrance bay.

(3) Construction of a New Dry Dock

For medium-sized ports such as Rangoon, and for vessels not longer than 400 ft., it is generally considered more economical to install marine slipways than dry docks. However, the magnitude of the tidal range and the heavy silt load carried by the Rangoon River create special problems, and it is doubted whether that conclusion is applicable to Rangoon, even though the length of vessels to be docked would not exceed materially the 400-ft. limit. The relative advantages of a floating dry dock versus a graving dock were discussed by various government agencies concerned. It was concluded that a graving dock was preferable to a floating dry dock. Although the first costs of the floating dock would be less, the annual maintenance and upkeep costs would offset the initial advantage. An additional argument against a floating dry dock in the Port of Rangoon is the lack of convenient areas in the harbor where water depth would be sufficient for the use of a floating dry dock of the required capacity. It appears that the larger dry dock, as well as the two smaller units, should be of the graving-dock type.

From the characteristics of the vessels to be docked, the new dry dock should have horizontal clearances of about 550 ft. in length and 70 ft. in width. The elevation of the sill should be determined by the general entrance conditions to the port. Assuming that with the improvement of entrance conditions the depth over the bar at Monkey Point would be at least 18 ft. at Mean Low Water Springs, the dock sill also should be at elevation minus 18. The dock coping would be at elevation plus 24, which is the general design elevation of the foreshores and wharves.

To be completely usable, a dry dock should be accessible at all stages of tide. This requirement excludes any location along Pazundaung Creek; therefore, the first selection of sites for the new dry dock would be along the Rangoon River. The dry dock should be located preferably as near as possible to the port entrance to facilitate the docking of a ship in distress. Furthermore, in order to eliminate duplication of engineering shops and equipment, it would be desirable to site the new dry dock in an area already serviced, at least to a large extent, by such equipment. Finally, the site should be large enough to permit the construction of an additional dry dock or dry docks, should the need arise in the future. Acceptance of these requirements would limit the choice of site to either the IWTB Dockyard at Dalla or to the grounds adjoining the Commissioners for the Port of Rangoon Work Shops. Suitable areas exist at both sites for the construction of a dry dock of the required size. Expenditures on additional shops and equipment would be more at the commissioners' site than at Dalla, and, due to river shoaling conditions, more extensive maintenance dredging will be required at the Commissioners' site. These disadvantages may be offset by better accessibility to railway and highway and less cost for transport of labor and material to commissioners' site than to Dalla. Final determination of suitability and of relative advantages of both sites would be possible only after evaluation of soil explorations and tests and extensive engineering investigations. The preliminary inspections seem to indicate that the cost of construction would be about the same at either site.

(4) Marine Repair Management

Should Government acquire Kahn's Dry Dock as recommended by the "Committee to Consider a Proposal for Construction of a Graving Dock in Rangoon," that dock might be placed under the jurisdiction of the Mercantile Marine Department because of its proximity to the Government Dockyard at Dawbon. The conversion of the wet dock of the Inland Water Transport Board at Dalla into a dry dock might place the operation of that unit under the Inland Water Transport Board. Should the new 550 ft. by 70 ft. dry dock be constructed at the Dalla site in the midst of the IWTB dockyard, it is natural to assume that that agency would then be held responsible for its operation. If the dock were sited at the Commissioners for the Port of Rangoon Work Shops, and if those shop facilities were used in the operation of the dock, either the natural operators would be the Commissioners or the dock and attendant shops would be leased to private operators. However, the operation of the three docks should be accomplished by one agency in order that the docking services may be utilized to the maximum efficiency.

The marine repair facilities now separately operated at Rangoon and at the outports and river terminals are these:

Rangoon

(*a*) Dalla Dockyard—Inland Water Transport Board.

(*b*) Rangoon Foundry—Inland Water Transport Board.

(*c*) Government Dockyard (Dawbon)—Mercantile Marine Dept.

(*d*) Kahn's Dry Dock—Mercantile Marine Dept.

(*e*) Commissioners for the Port of Rangoon Work Shops.

Akyab

(*f*) Arakan Flotilla Company.

(*g*) Mercantile Marine Department (construction approved).

Bassein

(*h*) Mercantile Marine Department (for minor repairs).

Moulmein

(*i*) Inland Water Transport Board.

(*j*) Mercantile Marine Department (under consideration).

Mergui

(*k*) Mercantile Marine Department (under consideration).

Mandalay

(*l*) Inland Water Transport Board.

(*m*) Mercantile Marine Department.

Rangoon has five separate government boatyards operated individually by three different agencies. In each case, the bulk of the marine repair is concentrated on their own craft. At three places there are two yards, each operated by different agencies. In all cases it can be assumed that the yards have duplicating facilities and can make approximately the same marine repairs. These yards are equipped with shops and equipment to do the same general work. Equipment, facilities, skilled labor, supervision, administration and engineering appears to be unnecessarily duplicated. The Arakan Flotilla Company is not a government agency but a subsidiary of the British India Steamship Navigation Company; however, the facilities of the yards at Akyab could be used by others in the area.

The most economical plan would be to merge all vessel and craft repair and to combine all equipment and personnel under one department, operated by one administration for the coordinated good of all departments. The Mercantile Marine Department's basic responsibilities are the conservation and maintenance of the entrance channels to the outports and the inland waterway channels, and the establishment and maintenance of aids to navigation. The basic function of the Inland Water Transport Board is the operation of vessels and craft for inland waterway transport. The chief responsibility of Commissioners for the Port of Rangoon is the handling of cargo. None of these agencies is basically suited to the repair and maintenance of marine equipment.

It is therefore recommended that a new department of Government be formed to realize the maximum of economy with a minimum of equipment, personnel and effort; a department which should function equally well in behalf of both government and private operators of marine craft and equipment. This separate department could be called the Department of Yards and Docks, and should be administered through the Ministry of Transport and Communications. The Department of Yards and Docks should assume the responsibility and operation of all existing government boatyards and marine facilities and should be the department responsible for the operation of the new dry docks.

h. Flotilla

The craft and floating equipment considered necessary for the proper and efficient operation of the Port of Rangoon are those proposed in the Commissioners' seven-year program. This equipment would include two buoy vessels, one survey vessel, one pilot vessel, one salvage vessel, one fire boat, two light vessels, six heave-up boats, eight harbor launches, seven work barges, two tugs, one bucket dredge and two hopper barges.

i. Miscellaneous

Items which are in this category and which are considered as necessary for the operation of the port and which also are included in the Commissioners' seven-year program include six more double sets of moorings, the rehabilitation of access facilities, construction of ancillary buildings and workers' quarters, the replacement of mechanical handling equipment and wharf cranes, and the rehabilitation of the electrical cable distribution system at the wharves.

j. Personnel Training

With the introduction of the proposed modern methods of cargo handling, the Commissioners would need qualified personnel for the organization and supervision of the operations. The planned extensive construction program would require engineering personnel familiar with modern practices of design and construction of various port structures and installations. As technical and engineering personnel with the required qualifications are scarce in Burma, it is recommended that the Commissioners for the Port of Rangoon initiate at an early date a personnel-training program for cargo handling and for the design and construction of port installations.

Both civil engineers and materials-handling engineers should be trained in such subjects as cargo handling, traffic flow, equipment selection and specification, and design of river and harbor works. Operations and maintenance of equipment should also be taught for prospective foremen. This group should be trained overseas. The operating and maintenance personnel should be trained at home, if possible by foreign instructors. The personnel classified as design and construction engineers should be trained overseas in both the technical and practical fields.

In the first stages of the port development program, both design and construction of proposed improvements should be carried out by foreign contractors. However, sufficiently qualified personnel of the Port Commission would be needed for supervision, checking and other operations. Gradually, all design work and possibly part of construction could be accomplished by the engineering and technical personnel of the Commissioners. For this purpose the design and construction divisions of the Commissioners' chief engineer's department should be enlarged progressively with additional personnel to be trained by those who were previously trained overseas.

	Foreign Cost (kyats)	*Local Cost (kyats)*	*Total Cost (kyats)*
General Cargo Wharves			
Stage I	4,12,67,100	5,23,11,900	9,35,79,000
Stage II	1,27,43,700	1,90,84,000	3,14,27,700
Stage III	68,38,900	99,26,900	1,67,65,800
Stage IV	67,98,800	1,02,06,400	1,70,05,200
Stage V	53,14,800	79,54,300	1,32,69,100
Subtotal	7,29,63,300	9,94,83,500	17,24,46,800
Foreshores			
Lanmadaw	2,23,67,000	3,14,56,000	5,38,23,000
Botataung	85,70,000	74,00,000	1,59,70,000
Subtotal	3,09,37,000	3,88,56,000	6,97,93,000
Rice Export Wharves			
Ahlone Wharf No. 1	17,80,000	25,40,000	43,20,000
Ahlone Wharf No. 2	58,40,000	73,76,000	1,32,16,000
Subtotal	76,20,000	99,16,000	1,75,36,000
Coal Import Wharf	48,75,400	72,17,800	1,20,93,200
Marine Repair and Dry-docking			
Improvement of Kahn's Dry Dock	10,000	30,000	40,000
Reconstruction of Wet Dock at Dalla	8,25,700	9,37,300	17,63,000
Construction of New Dry Dock	68,48,300	1,14,77,000	1,83,25,300
Subtotal	76,84,000	1,24,44,300	2,01,28,300
Total New Improvements	12,40,79,700	16,79,17,600	29,19,97,300
Flotilla	2,82,00,000	50,00,000	3,32,00,000
Miscellaneous			
Hydraulic Model Tests	9,00,000	1,00,000	10,00,000
Moorings	54,00,000	6,00,000	60,00,000
Cranes and Elec. Distribution System	38,00,000	9,00,000	47,00,000
Engineering Plant	3,20,000	80,000	4,00,000
Workers' Quarters	2,00,000	19,00,000	21,00,000
Subtotal	1,06,20,000	35,80,000	1,42,00,000
Personnel Training	9,00,000	3,00,000	12,00,000
Total Program	16,37,99,700	17,67,97,600	34,05,97,300

17. FIRST COSTS OF IMPROVEMENTS

Estimates were made of the construction and equipment costs of the modifications and improvements contained herein. Foreign and local costs were computed separately. Foreign costs include the initial purchase of equipment and freight allowance to Burma as well as technical assistance, supplies and materials not available locally; local costs include construction and labor costs and the cost of such materials and supplies which would be available in Burma. Since the equipment and foreign materials would be procured by and for the Government of the Union of Burma, import and customs charges are not included. These estimated costs are summarized in tabular form in the previous column.

18. ANNUAL CHARGES ON IMPROVEMENTS

Annual charges on the improvements include interest, amortization, maintenance and operating costs where applicable. Annual interest charge was determined at 5% of the total first cost on the foreign expenditures and 4% for the local costs. Annual amortization charges are considered as the annual instalments required to accumulate the foreign investment principal at 5% interest and the local investment at 4% for the periods of useful life of the various parts of the structures and plant. Maintenance costs were determined on estimated annual charges for upkeep and repair of the structures and equipment. The estimated useful life of the various components and the percentage used in determining the maintenance costs are as follows:

	Useful Life (years)	*[illegible] Rate [illegible]*
General cargo wharves	40	[illegible]
Retaining wall, Lanmadaw	25	[illegible]
Transit sheds and warehouses	25	[illegible]
Rail and road facilities	25	[illegible]
General cargo handling equipment		
Wharves	15	[illegible]
Foreshores	10	[illegible]
Rice export wharves	25	[illegible]
Rice-handling equipment	10	[illegible]
Coal-import wharf	25	[illegible]
Coal-handling bridges	25	[illegible]
Dry-dock structures	50	[illegible]
Dock gates and cranes	25	[illegible]
Dock pumps and mechanical equipment	15	[illegible]

Based on the above conditions the annual costs and charges were found to be as follows:

	Total Annual Costs (kyats)	
General Cargo Wharves		
Stage I	77,08,739	
Stage II	25,65,627	
Stage III	12,53,491	
Stage IV	12,73,997	
Stage V	9,91,890	
		1,37,93,744*
Foreshores		
Lanmadaw	41,90,175	
Botataung	12,66,669	
		54,56,844
Rice Export Wharves		
Ahlone Wharf No. 1	12,15,536	
Ahlone Wharf No. 2	18,73,928	
		30,89,464
Coal Export Wharf		10,67,914
Dry-docking Facilities		
[illegible] Dry Dock	7,660	
Conversion Daila Wet Dock	1,49,970	
New Dry Dock	12,90,130	
		14,47,760
Total Annual Costs		2,48,55,726

* In this amount K1,09,61,967 is the annual cost of fixed structures and K28,31,777 is for cargo-handling equipment and pallets.

19. ANNUAL BENEFITS AND SAVINGS

The annual savings and benefits which derive from the proposed improvements are of two types. The first is the direct saving in handling costs; the second results from the reduction in vessel turn-around time. The latter savings are frequently termed indirect benefits because the savings often are returned in the reduction of freight rates instead of direct premiums returned to the port operators. In the case where Government operates its own craft in commerce as in the India rice-coal trade of the Union of Burma Shipping Board and the Inland Water Transport Board, the savings incidental to reduction in turn-around time become direct savings.

a. General Cargo Over Wharves

In making a comparative economic analysis of various methods of handling general-cargo commerce, it is necessary to evaluate the handling costs on a common basis, such as equal periods of operation. In the determination of the number of wharves and the transit sheds and warehouses, working period has been determined as 200 shifts of eight hours each per year in order to accommodate efficiently the peaking of ship arrivals during various periods of the year. Therefore, in considering the output of traffic for the berths under the present system of operation and under the mechanized system proposed, this period of 200 single shifts is used.

On the assumption that the handling rate can be increased to the prewar rate of seven tons per hatch per hour (280 tons per shift per berth) by present methods, the annual tonnage of 56,000 tons per berth could be expected. For the 14 proposed berths the commerce which could be handled then would equal 784,000 tons as compared with the 2,704,400 tons which could be handled by mechanized equipment during the same period.

If the general-cargo commerce approaches the anticipated tonnages indicated in this report, the berthing facilities, wharves and warehouses would be provided, and in the comparative analysis, the annual costs and charges under both systems of operation would remain the same.

With present methods, the goods are handled by manpower and tractor-trailer trains. For the 14 wharves it is estimated that under present methods an average of four trains, or equivalent equipment, would be used per berth, a total of 56 trains, with first cost investment of about K11,00,000 and annual charges of about K1,10,000. Additional costs of operation of the tractor trains would be about K0.10 per ton for labor and about K0.16 per ton for fuel, a total of about K0.26 per ton.

It is estimated that a commerce of 2,704,400 tons of general cargo would be handled. However, the capacity of the wharves on the basis under consideration would be only about 784,000 tons. Thus, the remaining 1,920,400 tons would be handled by the only other means, lighterage. Lighterage costs would be at least K5.00 per ton plus an additional K2.00 for unloading.

Under present methods, it is estimated that at least three gangs of dock labor would be used per shift per berth at an average cost of K1.50 to K2.00 per ton at existing wages. In the next 20 years it can be expected that their wages will be increased by not less than 50%; therefore, the cost by handling with dock labor would be approximately K3.00 per ton.

To evaluate the cost differential in handling the general-cargo commerce under the present system, the cost per ton of cargo over the wharves and by lighterage would be:

	Kyats	Kyats
Over Wharves (784,000 tons)		
Interest and Amortization	1,10,000	
Equipment Operation at K0.26 ton	2,03,840	
Dock Labor at K3.00 ton	23,52,000	
		26,65,840
By Lighterage (1,920,400 tons)		
Lighterage Fees at K5.00 ton	96,02,000	
Unloading Lighters at K3.00 ton	57,61,200	
Transport to Warehouse at K2.00 ton	38,40,800	
Warehouse Labor at K2.00 ton	38,40,800	
		2,30,44,800
Total Handling Costs by Present Method		2,57,10,640
Average Cost per ton		9.50

In regard to direct operating conditions, it is recognized that the work would be carried on in two eight-hour shifts per day when required to minimize the costly lighterage. Evaluating the costs on that basis, the cargo handled over the wharves would be doubled to 1,568,000 tons at a handling cost of K53,31,680 and the cost of handling the remaining 1,136,400 tons of cargo by lighterage would be K1,36,36,800 totalling K1,89,68,480 per year or K7.02 per ton. It is to be noted that with even doubling the present rate of handling per shift or doubling the working period into 200 days of 16 hours each the tonnage handled over the 14 berths would only be 1,568,000 tons or not more than about 58% of the expected commerce.

Under the proposed method of mechanized handling of general cargo, the 14 berths and appurtenant equipment would be capable of handling the entire estimated general-cargo commerce of 2,704,400 tons in the 200 shifts of eight hours each per year. The estimated annual charges on the equipment would be K28,31,777 per year or K1.05 per ton. The operating costs of the equipment, including 25% for insurance and welfare, is estimated at K0.29 per ton, K0.19 for labor and K0.10 for fuel. Thus, the cost of handling 2,704,400 tons of general cargo per year by the proposed method would be:

Interest, Amortization and Maintenance	K28,31,777
Operating Equipment Costs at K0.29/ton	7,84,276
Total Handling Costs by Proposed Method	K36,16,053
Average Cost per ton	K1.34

If the improvements recommended in this Report, to obtain 14 berths for the handling of general-cargo commerce, are charged against handling costs, the totals become:

For 14 Berths	
Annual Costs and Charges of Fixed Structures	K1,09,61,967
Cost per ton handled	
Present Method (784,000 tons)	K14.00
Present plus 100% Overload* (1,568,000 tons)	K 7.00
Proposed Method (2,704,400 tons)	K 4.05

The total handling costs per ton then will be:

	Total Cost (kyats)	*Per Ton (kyats)*
Present Method—Normal (784,000 tons)		
Fixed Structures Charges	1,09,61,967	14.00
Handling Costs	2,57,10,640	9.50
Total	3,66,72,607	13.55†
Present Method—100% Overload* (1,568,000 tons)		
Fixed Structures Charges	1,09,61,967	7.00
Handling Costs	1,89,68,480	7.02
Total	2,99,30,447	11.05†
Proposed Method—Normal (2,704,400 tons)		
Fixed Structures Charges	1,09,61,967	4.05
Handling Costs	36,16,053	1.34
Total	1,45,78,020	5.39

* Using *two* shifts of eight hours each per day.
† On basis of total commerce of 2,704,400 tons.

These costs can be indicated in terms of direct annual savings in the following manner:

Comparison of Normal		
Cost of Handling, Present Method Normal (784,000 tons wharves; 1,920,400 tons lighterage)		
Total Annual Costs	K3,66,72,607	
Cost of Handling, Proposed Method Normal (2,704,400 tons wharves)		
Total Annual Costs	K1,45,78,020	
Total Annual Savings		K2,20,94,587
Comparison of Overload		
Cost of Handling, Present Method Overload (1,568,000 tons wharves, 1,136,400 tons lighterage)		
Total Annual Costs	K2,99,30,447	
Cost of Handling, Proposed Method Normal (2,704,400 tons wharves)		
Total Annual Costs	K1,45,78,020	
Total Annual Savings		K1,53,52,427

Of the total commerce of 2,704,400 tons to be handled over the wharves, about 2,150,000 tons would be of foreign import. Previously in this Report, it was shown that present demurrage time average was from about five to eight days per ton on the import goods at an average cost of about K1.81 per ton. With the new system of transit sheds and warehouses, and with the expedited handling and customs operations, it is not unreasonable to expect that the demurrage time and costs will be reduced by one half. Thus, at K0.90 per ton on the estimated import commerce of 2,150,000 tons, the apparent direct savings from that source would approximate K19,35,000 per year.

The indirect benefits which would be derived from the proposed improvements would accrue from the saving in vessel turn-around time. Although the average vessel carrying cargo to and from Rangoon would have a full cargo capacity of 6,000 to 6,500 tons, the part of the cargo with either origin or destination Rangoon probably would average not more than about 3,500 tons. If the ship is unloaded under present methods, on an average unloading rate of the prewar amount of seven tons per hatch per hour (200 tons per eight hours) the length of time the vessel would be in port would be about 12·5 shifts or 6·25 days of two shifts each. In the case of handling cargo with the proposed mechanized equipment, the average time for handling the cargo of 3,500 tons at 25 tons per hatch per hour would be about 3·5 shifts or 1·75 days of two shifts each. Thus, the saving in turn-around time per ship would be 4·5 days.

In handling the 2,704,400 tons of anticipated commerce, there would be required about 775 vessels per year on the basis of 3,500 tons per ship of Rangoon traffic. It is estimated that the cost of operating a vessel of this type will average about K4,800 per day. Normally a vessel has a fixed loading and unloading time limit established for it in any port and a premium is offered for handling in a shorter time while a penalty is collected if the time extends over the established period. Either the premium can be collected or the carrier can reduce the freight rates accordingly—in either case the consumer will benefit. It is not unreasonable to expect that at least 50% of these benefits will be returned to the economy of Burma. Therefore, at K2,400 per day saved in turn-around time, this benefit would approximate K83,70,000 (K2,400 × 4·5 × 775) per year.

The approximate total annual savings which would be realized, in comparing the proposed methods of cargo handling with the methods now in use, can be summarized as in the following tabulations. In the first tabulation, the Normal Comparison, the systems are compared and the savings evaluated on the basis of each system operating 200 shifts of eight hours each per year; in the second tabulation, the Overload Comparison, the present-method system is assigned 200 shifts of 16 hours each as compared with 200 shifts of eight hours each for the proposed-method system.

Normal Comparison	*Kyats*	*Kyats*
Direct Savings		
In Handling Costs	2,20,95,000	
In Demurrage and Storage	19,35,000	
		2,40,30,000
Indirect Savings		
In Vessel Turn-around Time		83,70,000
Total Savings per Year		3,24,00,000
Overload Comparison		
Direct Savings		
In Handling Costs	1,53,53,000	
In Demurrage and Storage	19,35,000	
		1,72,88,000
Indirect Savings		
In Vessel Turn-around Time		83,70,000
Total Savings per Year		2,56,58,000

b. General Cargo at Foreshores

As indicated previously the forecast total volume of cargo at the Lanmadaw and Botataung foreshores would be about 1,200,000 tons annually. It is estimated that with the elimination of the present congestion and with mechanization of cargo transport the increase in the cargo-handling rate would permit a reduction of handling costs by about K2.00 per ton. The total annual savings thus would amount to about K24,00,000.

The average net tonnage of sailing vessels calling at the Port of Rangoon is about 50 to 60 tons. Considering the larger craft of IWTB and others, it would appear that the cargo shipped in or landed from one vessel at the foreshores would not exceed 75 tons per vessel. For transport of 1,200,000 tons annually about 16,000 vessels would then be required. It can be reasonably assumed that among those vessels would be at least 1,000 larger vessels and that the savings in turn-around time, due to improved cargo-handling efficiency at the foreshores, would amount to at least two days per ship per year. It is estimated that the cost of operation of these vessels would be about K500 per day. The total indirect savings would then be K10.00,000 annually. The total direct and indirect savings and benefits which could be obtained at the Lanmadaw and Botataung foreshores as a result of proposed improvements would be the sum of these two classes of benefits or K34,00,000 per year.

c. Rice Export Wharves

(1) Ahlone Wharf No. 1

In considering the savings to be realized through the modification of Ahlone Wharf No. 1 and the use of the mechanized equipment, the basis of comparison should be made on 300,000 tons per year, the output of the wharf with mechanization in operation. Thus, for 300,000 tons per year under present conditions lighterage would be required to supplement the present output of the wharf. Because of present delivery restrictions of only about 1,000 tons per day, it is reasonable to assume that this wharf now could handle not more than about 150,000 tons per year and that the remaining 150,000 tons would be lightered. On these assumptions the present handling costs for the 300,000 tons would be as follows:

Handling cost at Wharf (150,000 tons)	*Cost per ton*	
	160-lb. bags	*210-lb. bags*
Average cost of carrying from railway cars and trucks to storage and stacking	K3.22	K2.67
Average cost of carrying from storage to ship's side	K2.94	K2.45
Stevedoring	K2.38	K2.38
Total	K8.54	K7.50

At Rangoon, the present ratio is about 20% of the bags in the 160-lb. size and 80% in the 210-lb. size; however, at the outports this condition is reversed and nearly all bags are of the 160-lb. size. It is believed that where manpower is used in the movement of the bags the trend will be towards the lighter bag and that a relation of about 80% of the 160-lb. size and 20% of the 210-lb. will prevail. Thus, the average handling charge will be 0·8 of K8.54 plus 0·2 of K7.50 or K8.33 per ton. The total cost at the wharf for 150,000 tons then would amount to K12,49,500.

For the remaining 150,000 tons required to be moved by lighter from storage to ship, on the basis of 80% of the 160-lb. and 20% of the 210-lb. sizes, and using the rate for average distance, the estimated cost would be:

	Cost per ton	
	160-lb. bags	*210-lb. bags*
Carrying bags from lighters to storage and stacking	K3.78	K3.17
Carrying bags from storage to lighters	K3.50	K2.83
Stevedoring	K2.38	K2.38
Total	K9.66	K8.38

Average charge of handling will be 0·8 of K9.66 plus 0·2 of K8.38 or K9.40 per ton. With a lighterage fee of K4.00, the total charge will be K13.40 per ton. Thus, the cost of moving the remaining 150,000 tons from storage to ship by lighter would approximate K20,10,000.

For the movement of 300,000 tons per year from storage to ship, assuming that Ahlone No. 1 is to be used for moving at least 150,000 tons, the total handling costs then would be the sum of shipping 150,000 tons from the wharf at K12,49,500 and the cost of shipping 150,000 tons by the lighter method at K20,10,000, or a total of K32,59,500 per year.

By modifying the present Ahlone Wharf No. 1 as previously indicated and by providing complete mechanization to permit the efficient handling of 300,000 tons per year from that unit, assuming that the unit cost of mechanized handling will amount to K3.21 per ton and about K2.00 per ton for stevedoring, the total unit handling cost will approximate K5.21 per ton. At this rate, the total cost of handling would equal K15,63,000 per year. When compared with the estimated cost of K32,59,500 per year for discharging 300,000 tons under present conditions, the direct annual savings would approximate K16,96,500.

The average load per ship is 5,000 tons and, under present midstream lighter-loading method of 1,000 tons per day (two shifts), it can be loaded in five days. When loading at the wharf by hand this rate is doubled or at the rate of about 2,000 tons per day (two shifts). With mechanization the rate is stepped up further to 2,400 tons per day in two shifts. The number of loading days then would be five days each for 30 ships and 2·5 days each for 30 ships, a total of 225 ship-days under the present method for loading the 300,000 tons. With mechanization, the number of ship-days would be 125, an indicated saving in turn-around time of 100 ship-days. At an average cost of K4,800 per day, this saving in turn-around time would amount to K4,80,000. It is reasonable to assume that at least 50% of this sum will be returned to the economy of Burma through reduced freight rates, time premiums and other benefits; thus, the benefit from reduction of ship turn-around time would amount to K2,40,000 per year.

The estimated total annual savings and benefits in improving and mechanizing the handling equipment at Ahlone Wharf No. 1 would be the sum of the direct annual saving of K16,96,500 and the indirect annual benefit of K2,40,000 or about K19,36,500 per year.

(2) Ahlone Wharf No. 2

The savings to be realized through the construction of Ahlone Wharf No. 2 would be the direct comparison of the cost of loading 300,000 tons per year by the present lighterage method at K13.40 per ton with the cost of moving the cargo by mechanical equipment at K5.21 per ton, as at Ahlone No. 1. Thus, the unit saving would be K8.19 per ton, and on the basis of 300,000 tons, the direct annual saving would be K24,57,000.

On the basis of 5,000 tons per ship and a loading time of five days per ship when using lighters, a total of 300,000 ship-days would be required. On the assumption of 2,400 tons per ship per day (two shifts) at mechanized Ahlone Wharf No. 2, there would be required a loading period of 125 ship-days; therefore, the saving in ship turn-around time would be 175 ship-days. At the rate of K4,800 per ship-day and assuming the proportion of 50% as benefiting the economy of Burma, the benefit due to the reduction in ship turn-around time would amount to K4,20,000 per year.

The estimated total annual savings and benefits in the construction and operation of Ahlone Wharf No. 2 would be the sum of direct annual saving of K24,57,000 and of the indirect annual benefit of K4,20,000 or about K28,77,000 per year.

(3) Combined Ahlone Wharves Nos. 1 and 2

When both wharves are in operation and moving 600,000 tons of rice per year, then the total annual savings and benefits will be as follows:

Direct savings		
Ahlone No. 1	K16,96,500	
Ahlone No. 2	K24,57,000	
		K41,53,500
Indirect benefits		
Ahlone No. 1	K2,40,000	
Ahlone No. 2	K4,20,000	
		K6,60,000
Total savings and benefits		K48,13,500

d. Coal Import Wharf

The direct savings in the cost of handling coal is the difference between the cost of handling by present methods and by the improved methods discussed in this report. On the basis of annually unloading 300,000 tons directly from the colliers and rehandling 225,000 tons per year from stockpile to truck and railway car or to barges and vessels, the rate per ton would be the annual fixed and operating costs divided by the cargoes handled. For simplification the fixed charges as interest and amortization were debited against the unloading operations and only the incremental operating costs were charged against the rehandling operations. Thus, the rate of unloading colliers was determined to be K3.56 per ton and for rehandling K0.25 per ton. The total annual direct savings would be:

Present rate, ship to storage	K7.88	
Proposed method	K3.56	
Unit saving	K4.32	
Annual savings (K4.32 × 300,000)		K12,96,000
Present rate, storage to car	K0.95	
Proposed method	K0.25	
Unit saving	K0.70	
Annual savings (K0.70 × 225,000)		K1,57,500
Total direct savings		K14,53,500

The indirect benefits derived from the proposed improvements would accrue from the saving in turn-around time of the ships and colliers. In the case of the colliers owned by Government and operated by the Union of Burma Shipping Board, the full benefit would be returned; in the case of the chartered vessels it is reasonable to assume that at least 50% of the benefits will be returned to the economy of Burma through reduced freight rates, time premiums and other benefits. On the basis of ship operations costs averaging K4,800 per day, the colliers of the UBSB would return K4,800 and the chartered ships K2,400 for each day reduction in turn-around time. For the economics of this study, it is assumed that the colliers of the UBSB would transport about 200,000 tons per year and that the chartered ships would carry the remaining 100,000 tons. In the case of transporting the 100,000 tons from Kalewa by barge fleets, these craft would be government-owned and their full savings would be returned to the national economy. The operation costs of the barge flotilla would be less than for the ships. Therefore, the net benefits should remain about the same.

Under present unloading and handling methods the discharge rate is equivalent to about 1,500 tons per day of two shifts. When wharves and mechanical unloading are used this rate can be increased to 3,000 tons per day of two shifts. Thus for 200,000 tons per year, the savings in turn-around time would be the difference between the time of unloading at the rate of 1,500 tons per day (134 days) and of discharging at the rate of 3,000 tons per day (67 days), which at K4,800 per day would result in an annual benefit of K3,21,600. For the remaining 100,000 tons the savings in turn-around time would be the difference between 67 days and 34 days, which at K2,400 per day would result in an annual benefit of K79,200. Thus, the indirect annual savings and benefits due to reduction in ship turn-around time would be K4,00,800 on the basis of 300,000 tons per year. The total annual savings then amount to the sum of K14,53,500 and K4,00,800 or a total of K18,54,300 per year.

e. Dry-docking Facilities

The annual fixed costs and charges were determined as K7,660 for the improvement of Kahn's Dry Dock, K1,49,970 for the conversion of the Dalla Wet Dock, and K12,90,130 for the construction of the new dry dock. On the basis of 365 days per year there derive daily unit charges of K20.99 for Kahn's Dry Dock, K410.88 for the IWTB converted wet dock, and K3,534.60 for the new dry dock required to repay the fixed annual costs and charges. To these charges would be added the administration, operation and shop costs, resulting in total repair rates which would be high when compared with the designated rates of the Singapore and Calcutta docks. However, those docks were constructed when costs were a great deal less and many should have been nearly depreciated by this time.

The Singapore and Calcutta docks now are considered to be operating at full capacity and Burmese craft would be required to await their turn. When the daily loss-in-business costs are considered in the waiting and repair period, the cost-to-Burma expense would increase materially.

At the present time it does not appear feasible to operate the recommended dry docks on a strictly commercial basis. However, in the national and international interest of Burma, particularly in consideration of national defense and independence, it is believed that the Government of the Union of Burma should have full and unrestricted control over the repair and maintenance of government vessels, especially those of the Burma Navy. That control can be attained only when the necessary facilities are available in home waters. These national requirements cannot be assigned definite monetary values, but they would more than offset the differential between a reasonable commercial rate and the total annual costs and charges. In other words, users of the dock facilities should be charged reasonable commercial rates, and Government should subsidize the remaining costs as a national maritime self-sufficiency charge.

20. ANNUAL BENEFITS *V.* ANNUAL COSTS ON CARGO HANDLING

To determine if proposed improvements are justified economically, it is necessary to compare the annual savings and benefits, or the annual returns, with the annual charges and costs. These returns may not be direct benefits and in most cases are not, but they include the over-all returns to the shipper, the consumer and the transporting agent, and they are benefits returned to the economy of the country. The ratios of annual benefits to annual costs are represented in the following tabulation:

	Annual Benefits (kyats)	*Annual Costs (kyats)*	*Ratios Benefits to Costs*
General Cargo Wharves			
14 Wharves	3,24,00,000	1,37,94,000	2·35 to 1·00
Foreshores	34,00,000	54,56,900	0·62 to 1·00
Subtotal	3,58,00,000	1,92,50,900	1·86 to 1·00
Rice Export Wharves	48,13,500	30,89,500	1·56 to 1·00
Coal Import Wharf	18,54,300	10,67,914	1·74 to 1·00
Total	4,24,67,800	2,34,08,314	1·81 to 1·00

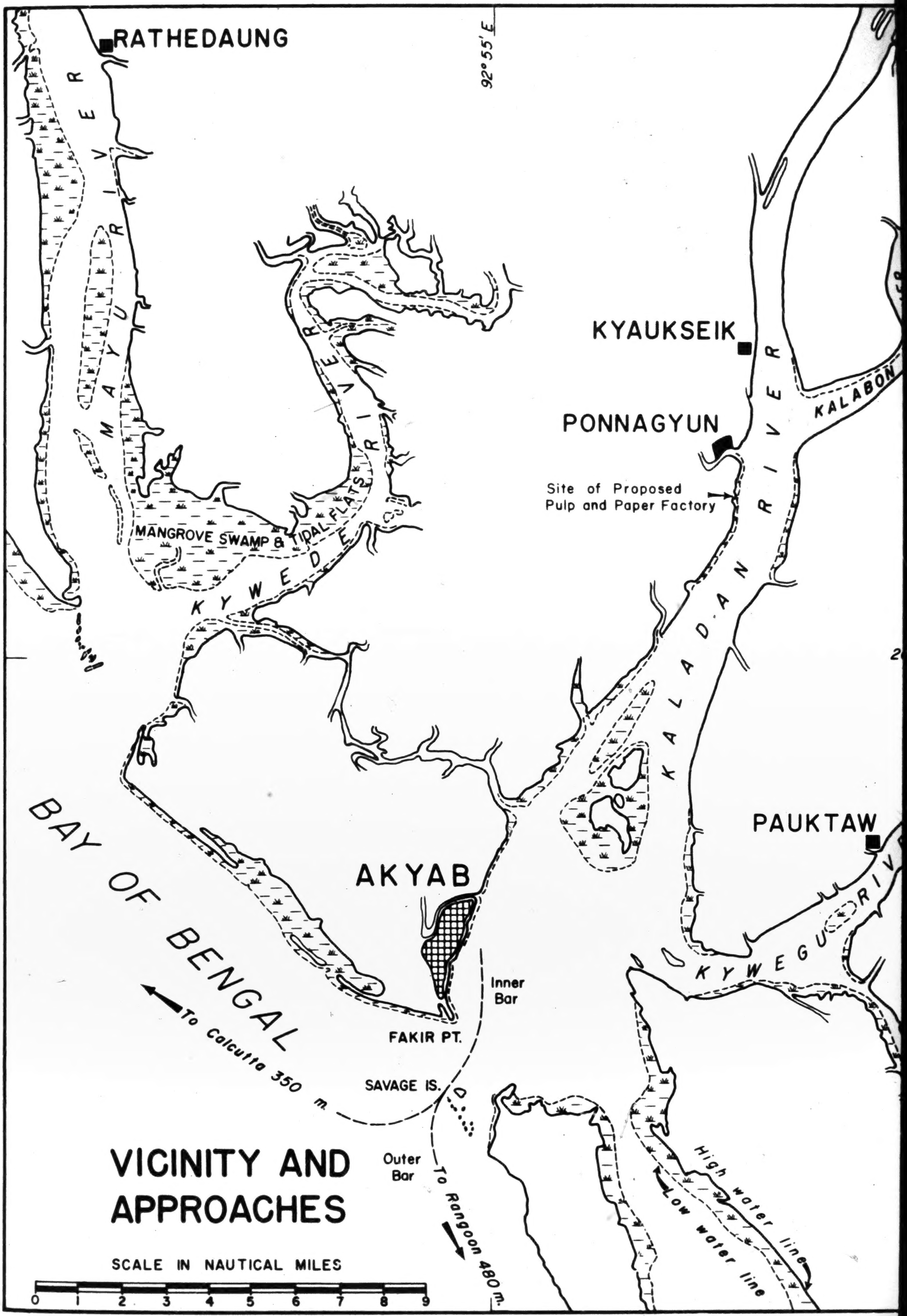
The preceding tabulation indicates that annual returns of the improvements proposed exceed the annual costs and charges by 80%. In the case of facilities for handling of all general cargo, the total annual returns exceed the total annual costs by 86% although the foreshore improvements in themselves are deficient by 38%. In the case of the rice export wharves benefits exceed costs by 56% and for the coal-handling wharf the excess amounts to 74%.

21. CONCLUSIONS

The Port of Rangoon, handling over 85% of the foreign commerce of Burma and over 40% of its coastal trade, plays a major role in the country; therefore, the degree of efficiency of this port influences to a large extent the pace of the economic development of the Union of Burma and the improvement of living standards of its people. Before the war Rangoon was reputed to be one of the most efficient ports of the east. In the postwar period the rate of cargo handling and port operations decreased considerably. It should be recognized that the methods of operation still used in many eastern ports are obsolete by modern standards and should the efficiency of the Port of Rangoon be raised only to prewar levels, such improvement could not be considered satisfactory. While some time ago cargo handling exclusively by coolie labor possibly could be justified, the requirements of modern times dictate an always larger application of mechanical process and methods.

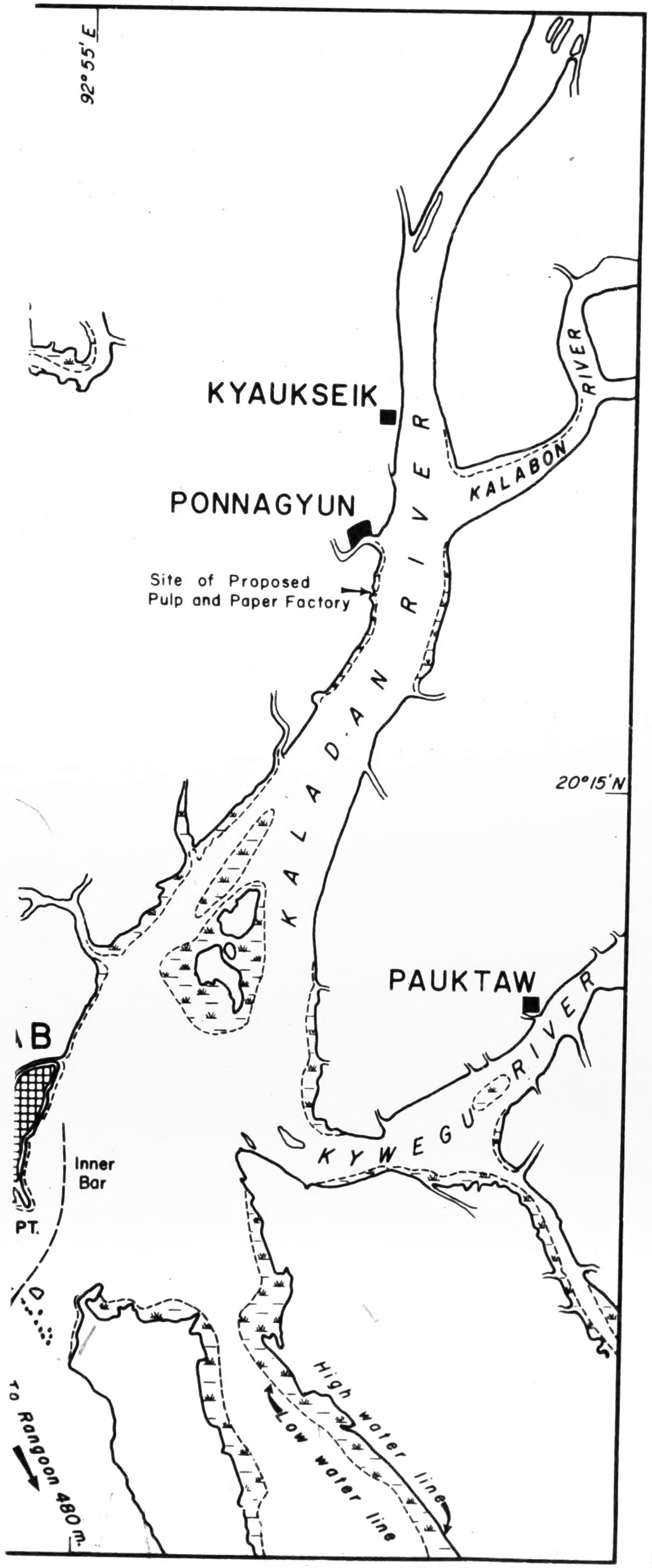
It has been shown in this chapter that the introduction of mechanical cargo handling at the Port of Rangoon would be justified even if the present volume of ocean-borne and river-borne commerce would remain constant. With the return to normal conditions, and an increase in commerce, then the present handling methods, based mainly on large-scale employment of coolie labor, would be entirely inadequate to cope with the increased volume of trade. Consequently, the proposed master plan for the Port of Rangoon incorporates a number of improvements to existing installations, the provision of new facilities, introduction of mechanical cargo handling and various other projects. The realization of these improvements, step by step, would improve progressively the efficiency of the port and bring it closer to the requirements of the modern concept of port design and operation. Most of the proposed projects would be profit-bearing and their financing could be suitably arranged through foreign or domestic loans. Some of the relatively minor recommended projects could not be made self-paying in themselves at present, but they are considered most essential in the national interest and would comprise an important working part of the port facilities.

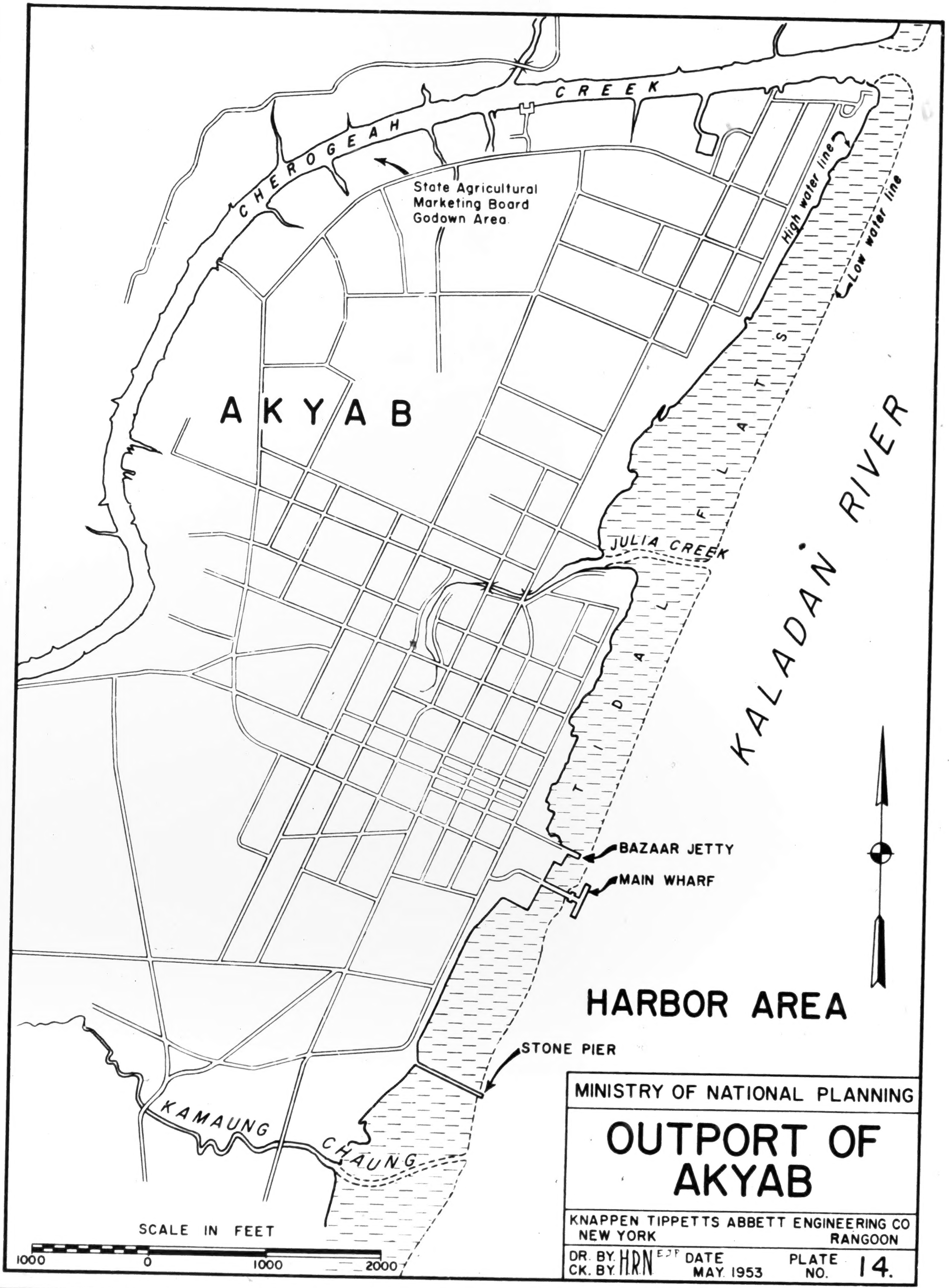
Concurrently with the initiation of the port development program and preferably prior to it, a number of organizational measures should be accomplished for the purpose of increasing the cargo-handling efficiency. High priority among these measures should be given to those tending to convey to the trade unions a better understanding of the relationship between wages, productivity and national economy and of the importance of improvement in productivity of dock labor. Measures tending to decrease the pilferage, to simplify and accelerate customs operations, and to accelerate removal of goods by consignees should also be pressed as of primary importance. These measures should be considered as essential to the modernization of the Port of Rangoon. The improvement of productivity of dock labor probably will present the most difficult problems, and its solution possibly could be facilitated by requiring higher standards of performance concurrently with the introduction of educational benefits. Other problems related directly to the realization of the port development program would present only the difficulties usually associated with the projects of this magnitude.



VICINITY AND APPROACHES

RATHEDAUNG
92°55'E
MAYU RIVER
KYWEDE RIVER
MANGROVE SWAMP & TIDAL FLATS
KYAUKSEIK
PONNAGYUN
KALABON
Site of Proposed Pulp and Paper Factory
KALADAN RIVER
PAUKTAW
KYWEGU RIVER
BAY OF BENGAL
AKYAB
Inner Bar
FAKIR PT.
SAVAGE IS.
Outer Bar
To Calcutta 350 m.
To Rangoon 480 m.
High water line
Low water line
SCALE IN NAUTICAL MILES
0
1
2
3
4
5
6
7
8
9


92°55'E
KYAUKSEIK
PONNAGYUN
Site of Proposed Pulp and Paper Factory
KALADAN RIVER
KALABON RIVER
20°15'N
PAUKTAW
KYWEGU RIVER
B
Inner Bar
PT.
To Rangoon 480 m.
High water line
Low water line


CHEROGEAH CREEK
State Agricultural Marketing Board Godown Area
AKYAB
High water line
Low water line
TIDAL FLATS
KALADAN RIVER
JULIA CREEK
BAZAAR JETTY
MAIN WHARF
STONE PIER
KAMAUNG CHAUNG
SCALE IN FEET
1000
0
1000
2000

HARBOR AREA

MINISTRY OF NATIONAL PLANNING

OUTPORT OF AKYAB

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON

DR. BY
CK. BY HRN DATE MAY 1953 PLATE NO. 14.

Improvements Expenditures Program

Table XII-8 (*see next page*) shows in tabular form the annual expenditures recommended to realize the improvements in time for them to be ready to serve the commerce demands. It is appreciated that the expenditure program is extremely heavy in the first seven years; however, it must be realized that the war damage was enormous, the rehabilitation requirements many, and that facilities must be available when needed if serious port congestion is to be avoided. To permit the business and industry of Rangoon and upper Burma to operate and advance unimpeded, the Port of Rangoon must function efficiently and effectively at the earliest possible date.

C. PORT OF AKYAB

1. GENERAL

Akyab is the westermost seaport of Burma and is located at the southernmost part of Paton Peninsula where the Kaladan River flows through a large estuary into the Bay of Bengal. It is the oldest rice exporting seaport in Burma and serves the combined section of productive paddy land of about 1,000 square miles. Akyab is the only harbor, other than Rangoon, where seagoing vessels can berth directly at a wharf. Akyab is the principal city serving the Arakan region and its principal income is derived from the rice trade. Twenty-five rice mills are within the city. In the prewar period Akyab averaged nearly 4% of the foreign trade of Burma; but in the postwar period this trade has recovered to less than 3%. Nearly 15% of Burma's coasting trade is handled through this port. The principal deep-water section is in the Kaladan estuary with the main port facilities on the foreshore. Cherogeah Creek, which essentially bounds the city on the north, forms the inner shallow-draft harbor for smaller vessels and country craft and it is on this stream that the rice mills are located. The deep-water harbor is exposed to considerable wave action with fetches of six nautical miles to the northeast and five to the southeast. Plate 14 entitled "Outport of Akyab" includes the port, inner harbor, entrance channel and general area.

2. PORT ADMINISTRATION

The Port of Akyab is under the general supervision of the Nautical Adviser and Principal Officer, Mercantile Marine Department, of the Ministry of Transport and Communications. However, as the port is operated on local funds, final decision on the utilization of these funds rests with the local Port Officer and the District Commissioner, guided by a local Port Advisory Board.

3. WAR DAMAGE AND REHABILITATION

The Port of Akyab suffered severely during the war with all marine facilities completely disabled. Both the main wharf and stone pier were bombed heavily and severely damaged and nearly 30 small vessels were sunk in Cherogeah Creek, blocking its subsequent commercial use. All mills were destroyed. In fact it is said that at the end of hostilities there was only one building left in the port and city. Recently all wrecks were removed from Cherogeah Creek, and the repairs to both the stone pier and main wharf are essentially complete.

4. ENTRANCE CHANNEL

From the sea buoy off Fakir Point and Fakir Reef, marking the entrance to the waterway, it is only about 2·3 nautical miles to the main wharf.

Approaching from the sea and about three nautical miles out from Fakir Reef light, there is a shoal area with depths as shallow as 15 ft. over which the seas break heavily during southwest monsoon weather. These shoals are often called the Outer Bar. On either side of the shoals there is a wide channel with depths in excess of 26 ft. Between the Outer Bar and Fakir Reef light depths vary from 26 to over 150 ft. and width clearances are unlimited. From the buoy the depths shoal fast so that in one nautical mile they have decreased to about 20·5 ft. MLWS and just below the entrance to the Akyab harbor to about 19·5 ft. MLWS in a section called the Inner Bar. The Inner Bar crossing appears to be the critical depth section of the entrance channel and in terms of tidal stages would be:

About 19·5 ft. at Mean Low Water Springs.
About 21·7 ft. at Mean Low Water Neap.
About 26·8 ft. at Mean High Water Springs.
About 24·7 ft. at Mean High Water Neap.

Considering the three-fathom contour (MLWS datum) as indicating the limits of the channel required for seagoing vessels, the widths can be considered as unlimited up to the Inner Bar area which is about 1·3 nautical miles above the Fakir Reef buoy. Here the channel begins narrowing down until a minimum width of about 700 ft. appears about 0·3 miles upstream. The average width of the channel near the harbor entrance appears to be about 1,300 ft. There is one wreck located about 1·7 nautical miles above the Fakir Reef light or opposite the Inner Bar; however, it does not interfere with navigation. There are no other wrecks or obstructions hazardous to navigation in the Akyab channel. No mines were placed during the war either in Akyab channel or harbor. The principal difficulties to navigation are the Outer and Inner

TABLE

RECOMMENDED ANNUAL EXPENDI-

(in 1,00

	Expenditures			*1st Yr.*	*2nd Yr.*	*3rd Yr.*	*4th Yr.*	*5th Yr.*	*6th Yr.*	*7th Yr.*
	Total	*Local*	*Foreign*							
General Cargo—Wharves										
Stage I	9,35,79	5,23,12	4,12,67	60,00	1,75,79	2,50,00	2,50,00	2,00,00		
Stage II	3,18,28	1,90,84	1,27,44					30,00	80,00	99,28
Stage III	1,67,66	99,27	68,39							
Stage IV	1,70,05	1,02,06	67,99							
Stage V	1,32,69	79,54	53,15							
General Cargo—Foreshores										
Lanmadaw	5,38,23	3,14,56	2,23,67					20,00	40,00	50,00
Botataung	1,59,70	74,00	85,70						10,00	30,00
Rice Export Wharves										
Ahlone No. 1	43,20	25,40	17,80	43,20						
Ahlone No. 2	1,32,16	73,76	58,40			20,00	50,00	62,16		
Coal Import Wharf	1,20,93	72,18	48,75	20,00	60,00	40,93				
Marine Repair and Dry-docking										
Improvement Kahn's Dry Dock	40	30	10	40						
Reconstruction Wet Dock at Dalla	17,63	9,37	8,26	5,00	12,63					
Construction New Dry Dock	1,83,25	1,14,77	68,48			10,25	57,00	59,00	57,00	
Flotilla	3,32,00	50,00	2,82,00	56,00	1,12,00	62,00	55,00	45,00	2,00	
Miscellaneous										
Hydraulic Model Tests	10,00	1,00	9,00		5,00	5,00				
Moorings	60,00	6,00	54,00		10,00	10,00	10,00	10,00	10,00	10,00
Cranes and Elect. Dist. System	47,00	9,00	38,00		1,00	1,00	10,00	15,00	15,00	5,00
Engineering Plant	4,00	80	3,20	2,00	2,00					
Workers' Quarters	21,00	19,00	2,00	3,00	3,00	3,00	3,00	3,00	3,00	3,00
Personnel Training	12,00	3,00	9,00		2,50	2,50	2,50	2,50	2,00	
Totals	34,05,97	17,67,97	16,38,00	1,89,60	3,83,92	4,04,68	4,37,50	4,46,66	2,19,00	1,97,28

Bars, where pilot service is required. There are no sharp curves and the courses are relatively straight, but the bar conditions are variable, shifting continuously in the alluvial deposits, and channel movement and current knowledge of these conditions are required for safe and dependable transit.

5. HARBOR AREA

The main harbor for seagoing commerce at Akyab is in the Kaladan River estuary fronted by the city. The central section of the channel, as defined by the 18-ft. contour, averages about 2,200 ft. in width and has depths varying from about 19 to 27 ft. MLWS. This condition, extending for over two miles upriver, offers a good anchorage for vessels and for the lighterage of cargo. Opposite the section between the stone pier and the main wharf the width of the channel has a tendency to narrow down, and here widths as little as 1,000 ft. can be expected. Along the Akyab foreshore, and especially in front of the section from the stone pier to the main wharf, there is a tendency for silt deposition, and maintenance dredging usually is required in this section. A channel about 600 ft. along the main wharf was dredged out in the beginning of 1953 to about 30 ft. depth and was connected to the deep channel to the east. Generally, the ships are loaded in the area opposite or north of the city to a draft of 22 to 23 ft. Further loading to a draft over 30 ft. is possible in the area downstream from Akyab nearer the mouth of the river.

Cherogeah Creek, on both banks of which are located all Akyab rice mills, serves the traffic of country boats bringing paddy to the mills and of lighters transporting rice bags from mills to ships. It

XII - 8

TURES, PORT OF RANGOON

of kyats)

8th Yr.	*9th Yr.*	*10th Yr.*	*11th Yr.*	*12th Yr.*	*13th Yr.*	*14th Yr.*	*15th Yr.*	*16th Yr.*	*17th Yr.*	*18th Yr.*	*19th Yr.*	*20th Yr.*	*21st Yr.*
60,00	49,00	55,00	62,66	50,00	40,00	40,00	50,00	40,05	32,69	30,00	25,00	25,00	20,00
50,00	50,00	50,00	60,00	50,00	50,00	50,00	40,00	28,23					
40,00	50,00	29,70											
1,50,00	1,49,00	1,34,70	1,22,66	1,00,00	90,00	90,00	90,00	68,28	32,69	30,00	25,00	25,00	20,00

also offers a protected harbor to lighters and shallow-draft government craft during rough weather in Kaladan River estuary.

Foreshore shoaling presents the principal obstruction to port operation at Akyab. Until the completion in 1953 of dredging in front of the main wharf, berthing of ships at this wharf was not possible. There are no wrecks or other obstructions in the harbor.

6. ANCHORAGES

Through the assistance of the United States ECA/TCA program, two mooring buoys have been installed recently in the harbor area opposite Akyab.

7. WHARVES AND JETTIES

The principal wharf is the Main Wharf, a T-shaped structure extending into the river, at which it is possible for vessels to berth and transfer cargo. The length of face of the Main Wharf is 375 ft. The other principal structure is the stone pier which extends out from the shore and terminates with a pontoon jetty. Before the war the stone pier was used by boats of the Arakan Flotilla Company. It is planned to extend the pier 50 ft. farther into the stream prior to installation of the pontoon jetty which is being assembled at Rangoon. Upstream of the main wharf and adjacent to it is the bazaar jetty which serves country boats and other small craft.

Along the banks of Cherogeah Creek there are a large number of small docks and jetties of the rice mills for sampans, country craft and lighters. These jetties serve for unloading of paddy and loading of rice bags and are not available for general-cargo handling.

8. TRANSIT SHEDS AND WAREHOUSES

At present there is only one public warehouse, about 100 ft. by 90 ft., for general cargo. It is located in the fenced-in area enclosing the Main Wharf and the port office. In the same area are located also the following buildings:

- 2 Sheds for passengers, customs, health service, etc.
- 1 Oil warehouse.
- 1 Nissen hut, serving as a shop.
- 1 additional general-cargo godown will be built shortly.

All sheds and godowns are of steel-frame construction with corrugated sheet-metal roof and walls.

On the right bank of Cherogeah Creek the State Agricultural Marketing Board has six godowns (five of timber construction with corrugated sheet-metal roof and walls, and one of bamboo construction), with a combined storage capacity of about 10,000 tons; however, these godowns are used for sorting out damaged rice, for repair of bags and other general uses, because practically all rice storage is in the mill's godowns.

9. CARGO-HANDLING EQUIPMENT

The cargo-handling facilities include one steam crane (seven tons) two hand cranes (two tons), one tractor crane (two tons). This equipment is old and in poor condition and is in need of early replacement. A request, made of ECA/TCA for two six-ton travelling diesel-electric cranes and one 15-ton crane, was not acted upon. Consequently it is planned to acquire the necessary wharf cranes out of port funds.

10. MARINE REPAIR

The existing marine repair facilities at Akyab are owned and operated by the Arakan Flotilla Company for servicing the craft of their own fleet. At present, Government has authorized the Nautical Adviser to construct an additional boatyard, estimated to cost about K5,00,000. This boatyard would contain three shipways and attending work shops and is to service the 45 craft now assigned to the Port Officer. The new boatyard is to be located adjacent to the repair unit of the Arakan Flotilla Company. It has been previously recommended that all marine repair facilities in Burma should be taken over by a new government agency, the proposed Department of Yards and Docks.

11. LABOR SUPPLY

There is an apparent unwillingness of local labor to engage in coolie work. The labor force is practically all of Indian extraction and because of the restrictions against immigration of Indians there is a scarcity of labor.

12. COMMERCE

Practically all commerce at the Port of Akyab is in paddy, rice and rice products, with minor tonnages of civil and military supplies and general merchandise. In the export of rice, Akyab occupies fourth place among the ports of Burma, after Rangoon, Bassein and Moulmein. In the prewar period from 1924 through 1941, Akyab averaged about 239,000 long tons of commerce annually, varying from a low of about 198,000 tons in fiscal year 1925–26 to a high of about 279,500 tons in 1933–34.

Subsequent to the war, Akyab still has been serving as the principal port for the Arakan area; however, because of the extreme damage to the port, city and milling area, it has had a very slow recovery in commerce. During the last three fiscal years the tonnage of seaborne commerce was as follows:

	Imports (Misc. Cargo)	*Exports (Misc. Cargo)*	*Exports (Rice and Rice Products)*	*Total*
1949–50	10,747	739	78,098	89,584
1950–51	15,462	1,284	84,480	97,226
1951–52	16,533	1,350	105,487	123,390

The export of rice in calendar year 1951 was 110,730 tons and in 1952 was 98,936 tons with a carry-over of about 20,000 tons to 1953.

For an estimate of the future traffic in the Port of Akyab it is reasonable to assume that with the return of normal conditions and the full development of cultivated land in the district, the export of rice and rice products from Akyab will exceed the prewar level and probably may reach 250,000 to 300,000 tons a year. Before the war the general-cargo trade of Akyab with India was direct; at present, India's trade is diverted to Rangoon with transhipment to Akyab. There is little prospect for a future substantial increase in the volume of general-cargo trade.

13. CARGO HANDLING

a. General Cargo

The small annual volume of general cargo in the Port of Akyab simplifies the problems connected with its handling. Until the completion of dredging in front of the Main Wharf the cargo was lightered from ship to shore. With the start of operation of the Main Wharf the cargo will be unloaded directly on the wharf and transported over the wharf trestle by coolies to customs, to the storage godown, or to the trucks of the consignees, as the case may be. Rail tracks are provided in the port yard and on the trestle and the cargo can be transported on rail hand-platforms. The Main Wharf and other existing facilities are more than adequate for handling of the present volume of general cargo.

b. Export of Rice

At present practically all milling of paddy from the Akyab district is concentrated at Akyab. There are only two small mills up-country with production of about 2,000 tons a year. The balance or 25 mills are located along the banks of Cherogeah Creek, mostly on the right bank. All delivery of paddy is by country boats; shipping of rice bags from mills to ship's side is by lighters. In 1952 not more than 2,000 tons were shipped out from SAMB godowns. Should new mills be built up-country, the tonnage to be transported (rice instead of paddy) will be reduced, but the only economical way to deliver it to Akyab and to ship's side will be by water in lighters and country boats.

Unloading of paddy from country boats to the mills and loading of rice bags from mills to lighters is by hand with coolie labor. The loaded sampans, country boats and empty lighters have to wait their turn and interfere with the traffic on the creek. To avoid collisions the barges and lighters can leave and enter the creek only against tide. The slow movement of vessels in the creek resulting from slow handling limits the over-all clearance capacity of the creek to 1,000 to 1,200 tons a day. Consequently, only one ship can be loaded at a time. When it is necessary to load two ships simultaneously, the rate of loading of a ship is reduced to 200 to 300 tons per shift, or 500 to 600 tons a day. The records of loading of five ships in January and February 1953 indicate that a total of 23,000 tons was loaded in 43 days, with a rate of loading between 400 tons and 780 tons a day, or an average of 530 tons a day. According to the records of Arakan Flotilla Company, before the war loadings often attained 3,000 tons per day.

The prevailing rates of handling are:

	Per ton
Unloading of paddy from country boats to mills	K1.25
Loading of rice bags from mills to lighters:	
For 100 bags of 160 lbs. at K8.00/100	K1.12
For 100 bags of 210 lbs. at K10.00/100	K1.07
Lighterage, including slinging charge, for rice	K5.50
Lighterage, including slinging charge, for bran	K6.50

In most cases 160-lb. bags are used for rice and 180-lb. bags for bran. Total cost of handling of 160-lb. bags of rice, from mill to f.o.b. ship therefore is K1.12 plus K5.50 or K6.62 per ton.

14. CONCLUSIONS

With the completion of the schedule rehabilitation, reconstruction and dredging operations the principal outstanding measures remaining would be the procurement and installation of the three cranes. Maintenance dredging must be continued to keep the harbor open for deep-drafted vessels. Cherogeah Creek should be dredged and widened as much as possible, and anchorage basins provided to permit freer movement of traffic and to create harbors-of-refuge for smaller craft during the monsoon season. Marine repair should be consolidated in one boatyard and duplicating services avoided.

It is considered that the very low rate of ship loading and the resulting excessively long turn-around time of vessels are the direct result of a too slow rate of handling of paddy and of rice bags at the mills. It can be assumed that the scarcity of labor will continue, being direct consequence of the policy of Burmanization and of apparent unwillingness of local population to engage in coolie work. This port is therefore an ideal starting point for a program of mechanization and a study should be instituted at an early date with the object of establishing facilities that can be used as a demonstration and testing ground as well as a means of actually improving handling of paddy, bagged rice and other cargo. This study should be undertaken by the proposed new Department of Yards and Docks in collaboration with the State Agricultural Marketing Board and should include overland transport of rice from the mills to the main wharf.

15. ESTIMATED REQUIRED EXPENDITURES

The estimated expenditures for the Port of Akyab are as shown in the following tabulation. These costs have been separated into foreign costs and local costs: foreign costs represent the expenditures for equipment, supplies and materials not available locally; local costs are the expenditures for labor, materials and supplies available in Burma.

	Foreign Costs (K)	*Local Costs (K)*	*Total Costs (K)*
Service craft and pilot vessels	4,50,000	50,000	5,00,000
Maintenance equip. (prorated)	9,00,000	1,00,000	10,00,000
Channel and port clearance	50,000	17,00,000	17,50,000
Aids to navigation	90,000	10,000	1,00,000
Cranes	4,50,000	50,000	5,00,000
Dockyards	1,50,000	3,50,000	5,00,000
Total	20,90,000	22,60,000	43,50,000

The recommended improvements and expenditures should be accomplished in the next five fiscal years.

Since channel and port clearance (principally Cherogeah Creek), aids to navigation, installation of cranes and consolidation and improvement of dockyards should be accomplished within the first two fiscal years, the annual expenditures for those years will be large. The recommended annual expenditures are K17,25,000 each for the first and second year and K3,00,000 each for the following three years.

16. SUMMARY OF RECOMMENDATIONS

In summary, with respect to the Port of Akyab, it is recommended that:

(*a*) The scheduled port and channel rehabilitation be expedited.

(*b*) Cherogeah Creek be dredged and widened.

(*c*) The wharf cranes necessary to accelerate cargo handling be purchased.

(*d*) Marine repair be consolidated in one boatyard.

(*e*) Maintenance dredging be continued.

(*f*) A study be initiated on the feasibility of mechanization of facilities used to handle paddy, bagged rice and other cargo.

D. PORT OF BASSEIN

1. GENERAL

The City and Port of Bassein are located on the Bassein River about 72 nautical miles upstream of the Diamond Island light, the beacon indicating the entrance to the waterway, and about 65 miles upstream of the mouth of the river proper. The Bassein River is in an alluvial basin and forms a part of the Irrawaddy River delta system. Navigation by local barges and sampans is carried out on the river to the Irrawaddy by a number of interconnecting channels; however, the principal route of inter-traffic is on the connecting Panmawadi River which is traversed by the Inland Water Transport Board craft. Seagoing-vessel traffic is confined to the Bassein River itself to Bassein where cargo transfer is accomplished through lighterage. It is the farthest inland seaport in Burma and the second largest port, with an annual rice export exceeded only by the Port of Rangoon. Situated on the westernmost tributary of the Irrawaddy and in the rich paddy-land delta it thus becomes a natural point of export for paddy, rice and rice products.

The Port of Bassein provides anchorage areas in the river for seagoing vessels but because of the shoals and silting along the foreshores the transfer of cargo from pontoon jetties and small piers to the ships anchored in midstream is possible only by using lighters. Generally, the depths in the harbor area and in the entrance channel permit loading of vessels only to a limited draft, and to complete the loading the ship usually proceeds to the Port of Rangoon.

In the prewar period Bassein averaged over 6% of the foreign trade of Burma, and in the postwar period this commerce has increased to nearly 10%. Less than 1% of Burma's coasting trade is handled through this port. Plate 15 entitled "Outport of Bassein" shows the pertinent features of the port and entrance channel.

2. PORT ADMINISTRATION

The Port of Bassein is under the general supervision of the Nautical Adviser and Principal Officer, Mercantile Marine Department of the Ministry of Transport and Communications. However, as the port is operated on local funds, final decision on the utilization of these funds rests with the local Port Officer and the District Commissioners guided by a local Port Advisory Board.

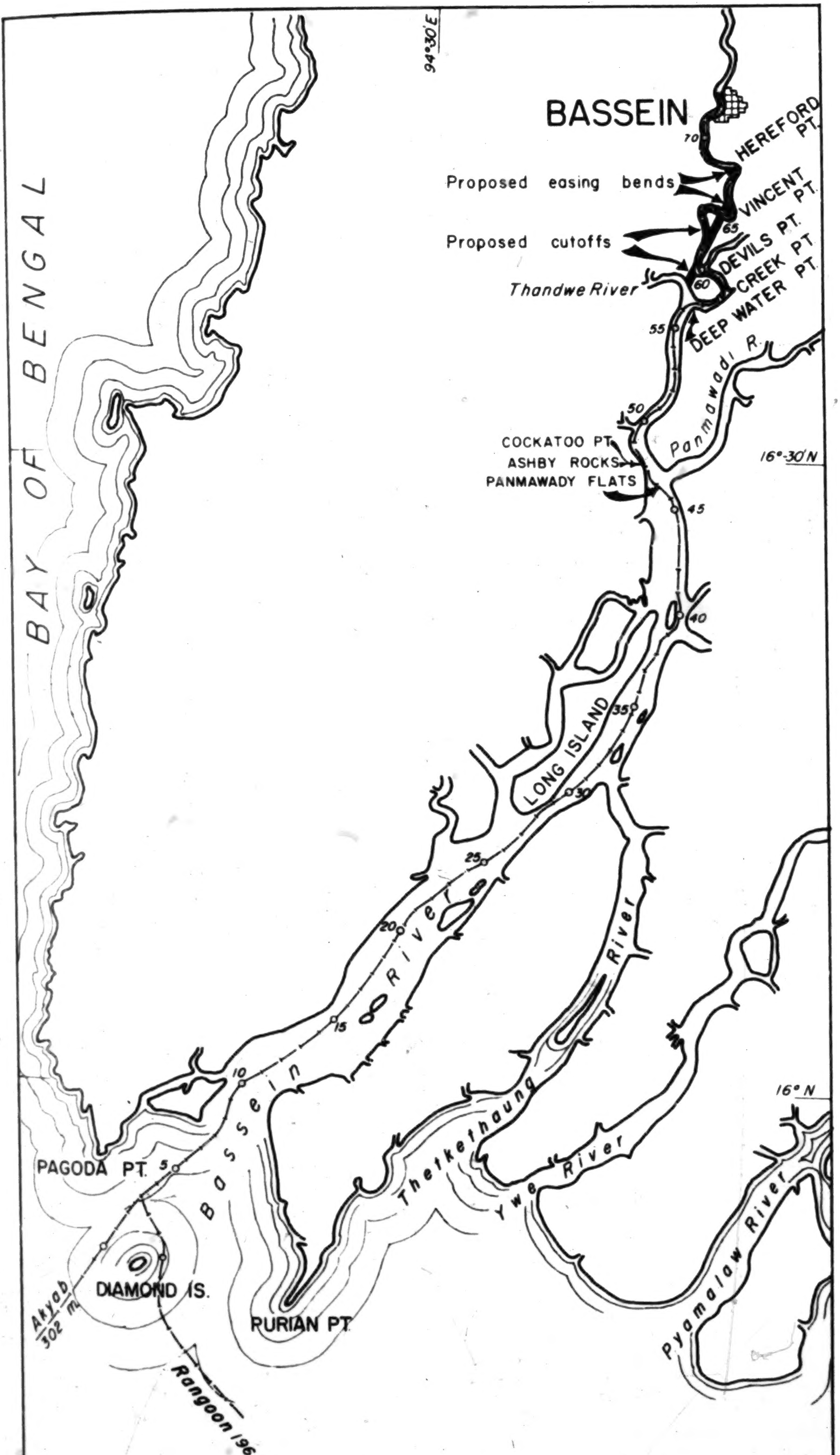
3. WAR DAMAGE AND REHABILITATION

There was very little war damage to the port facilities at Bassein. Two pontoon jetties were sunk but have been removed since. Rehabilitation activities are being carried out in the course of the maintenance program. New pontoon jetties for replacing those destroyed are part on order in the United Kingdom and part in fabrication at the local yard. In their planning program the Mercantile Marine Department also plans to rehabilitate the Diamond Island pilots' quarters.

4. ENTRANCE CHANNEL

In the first 46·5 miles of channel above Diamond Island, or to the mouth of the Panmawadi River, there are good depths of water, no sharp bends, and adequate widths for safe and dependable two-way navigation. At the mouth of Panmawadi River a serious shoal occurs which is known as Panmawadi Flats and depths as little as 18 ft. MLWS are encountered. From the mouth of the Panmawadi River to the harbor limits of Bassein, the Bassein River offers a tortuous channel requiring extreme care in the navigation of the larger vessels, and from the mouth of the Thandwe River (Mile 56) the curves are of such short radii as to prevent two-way navigation.

Immediately upstream of Panmawadi Flats, the channel swings sharply inshore at Cockatoo Point and at this point there are rock shoals known as the Ashby Rocks. While not of critical depth, the shoals, plus sharp channel curvature, present difficult navigating conditions. From Mile 56 to the port of Bassein the river is narrow and extremely tortuous. There are nine sharp bends in this reach, six of which are of very short radii and extremely difficult to navigate. These are at Deep Water Point, Creek Point, Devils Point, Chanawah Point, Vincent Point and Hereford Point. In general, the widths of the river in the sections


94°30'E
BASSEIN
HEREFORD PT.
VINCENT PT.
DEVILS PT.
CREEK PT.
DEEP WATER PT.
Proposed easing bends
Proposed cutoffs
Thandwe River
Panmawadi R.
COCKATOO PT.
ASHBY ROCKS
PANMAWADY FLATS
16°-30'N
16° N
LONG ISLAND
Bassein River
Thetkethaung River
Ywe River
Pyamalaw River
BAY OF BENGAL
PAGODA PT.
DIAMOND IS.
PURIAN PT.
Akyab 302 m.
Rangoon 196 m.
70
65
60
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5
SCALE IN NAUTICAL MILES
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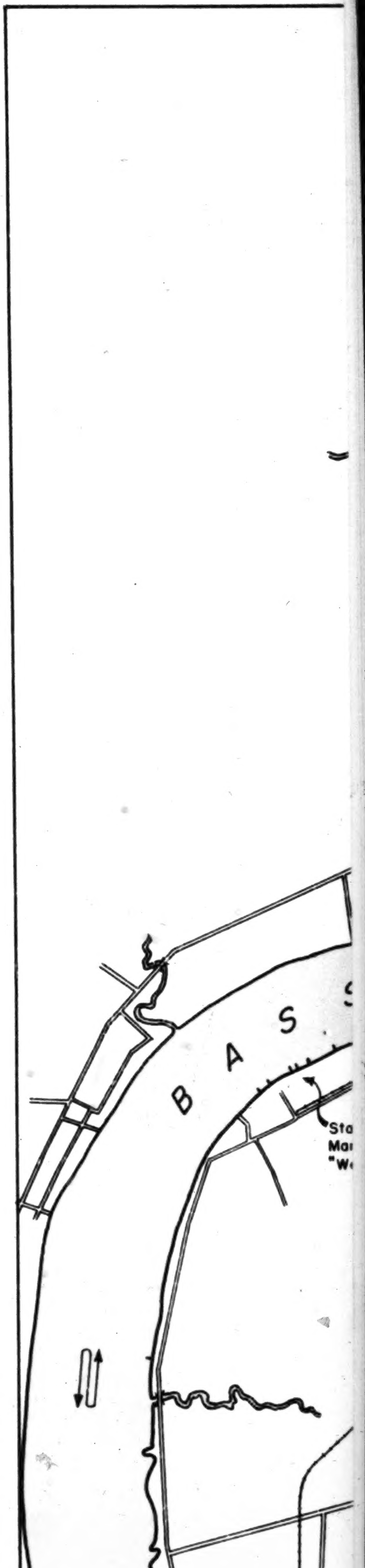
VICINITY & APPROACHES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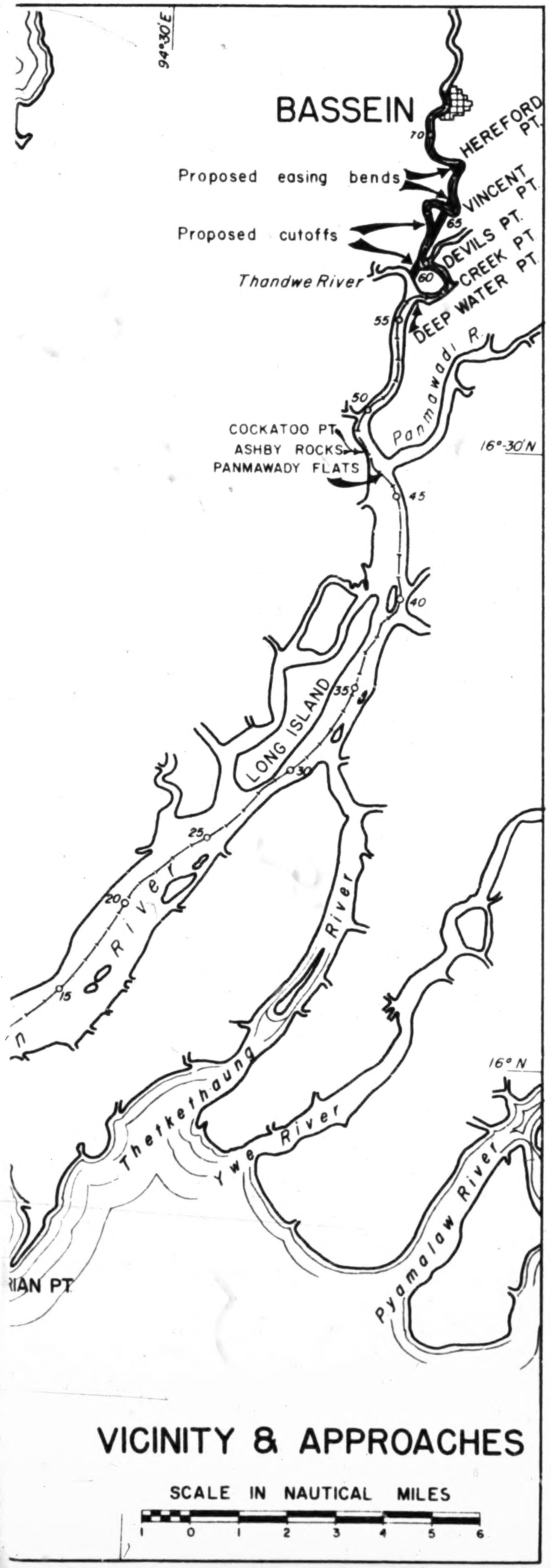
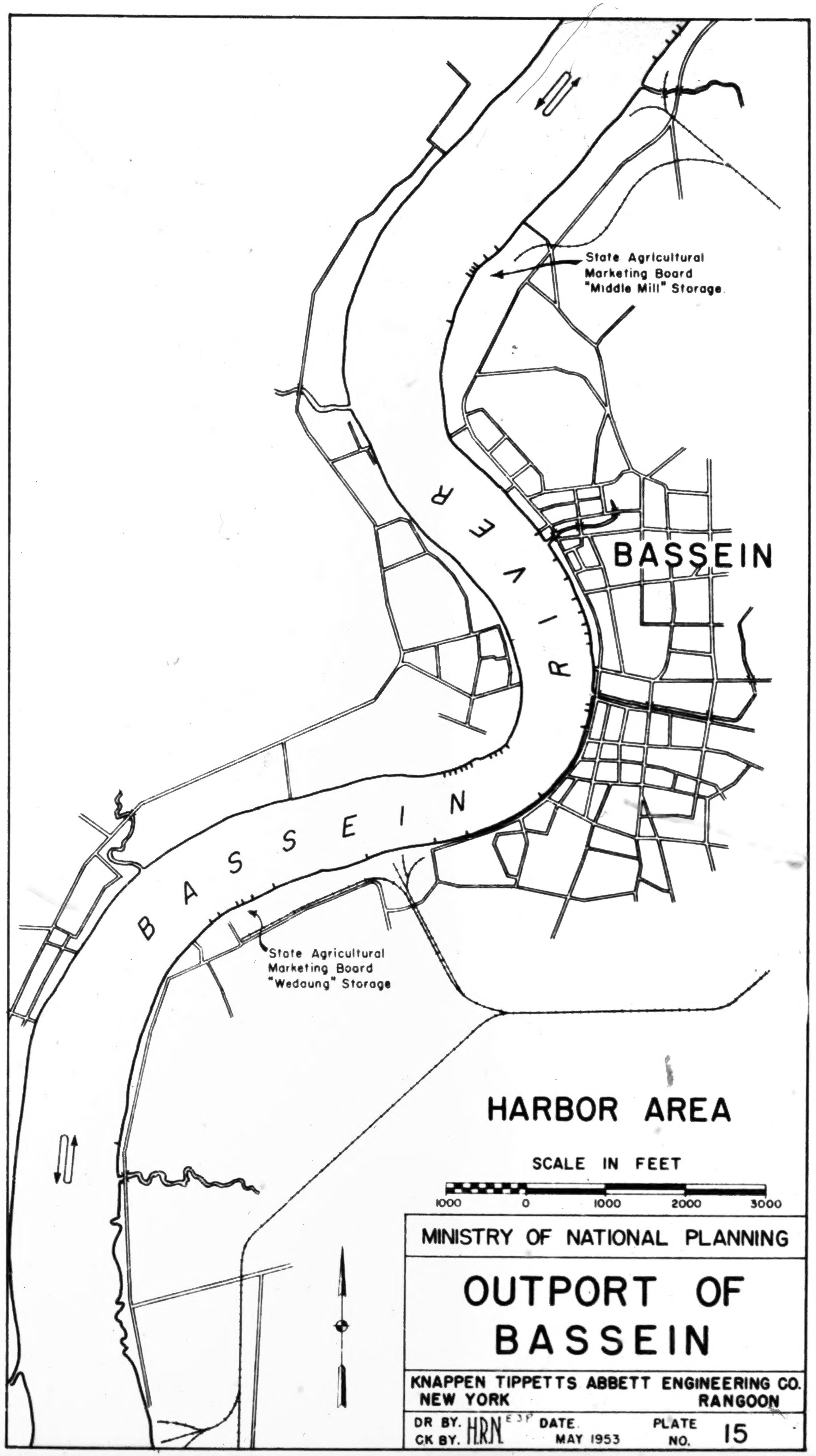

94°30'E
BASSEIN
70
HEREFORD PT.
Proposed easing bends
VINCENT PT.
65
Proposed cutoffs
DEVILS PT.
CREEK PT
DEEP WATER PT.
Thandwe River
60
55
Panmawadi R.
50
COCKATOO PT
ASHBY ROCKS
PANMAWADY FLATS
16°30'N
45
40
35
LONG ISLAND
30
25
20
River
15
Thetkethaung River
Ywe River
Pyamalaw River
16° N
RIAN PT
SCALE IN NAUTICAL MILES
1 0 1 2 3 4 5 6

VICINITY & APPROACHES


BASSEIN
BASSEIN RIVER
State Agricultural Marketing Board "Middle Mill" Storage
State Agricultural Marketing Board "Wedaung" Storage
SCALE IN FEET
1000 0 1000 2000 3000

HARBOR AREA

MINISTRY OF NATIONAL PLANNING

OUTPORT OF BASSEIN

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR BY. HRN DATE MAY 1953 PLATE NO. 15
CK BY. HRN.

between the bends appear to average about 1,200 ft. and offer no particular difficulties to navigation; however, in the bend areas the widths narrow down to about 400 ft., particularly at Creek Point, Devils Point and Chanawah Point. Because of the narrow width of the river, depths in the reach from Cockatoo Point to Bassein are great, usually varying from about 28 to 100 ft., MLWS datum.

There are no wrecks which interfere with navigation. The principal obstructions are the Ashby Rocks at Cockatoo Point and the shoal areas of Panmawadi Flats. No mines were placed by the Allied Forces either in the Bassein River or in the harbor area. There are no particular difficulties encountered in navigating the first 46·5 nautical miles upstream of Diamond Island, or until the river crossing at Panmawadi Flats is reached, approximately at the mouth of the Panmawadi River. There probably the most critical depth restriction of the entire waterway up to the harbor of Bassein is met and serves as the control point governing the draft of vessels. Depths over this shoal area average:

About 18·3 ft. at Mean Low Water Springs.
About 19·8 ft. at Mean Low Water Neap.
About 24·3 ft. at Mean High Water Springs.
About 23·0 ft. at Mean High Water Neap.

During the month of February 1953 the minimum draft in channel was 20 ft. and the maximum 22 ft. 4 in. Above the mouth of the Thandwe River (Mile 56) the widths of the Bassein River and the degree of curvature of the bends are inadequate for safe and dependable one-way navigation and entirely prohibit any two-way navigation. This section requires extreme care in navigation.

5. HARBOR AREA

Bassein harbor is a section of the Bassein River in front of the city and approximately three miles long, beginning about 70 nautical miles upstream of Diamond Island. The average usable width of the river in the harbor area is a little over 1,000 ft; however, there is a great amount of local barge and sampan traffic and anchorage along the river banks, thus reducing the usable anchoring and turning width to about 700 ft. At the upper limits of the harbor the channel is narrower, reducing in width to about 700 ft. of waterway with probably not more than 400 to 500 ft. at the most available for turning. Depths are good throughout the harbor area, ranging from about 32 ft. to 85 ft. MLWS. The main part of the waterfront, located on the inner river bend, is silting up. Therefore, the loading of seagoing vessels must be carried on in midstream, from one half to one mile downstream from the centre of the city in the greater width of the river. Because of draft limitations in the channel only partial loading of ships is possible. To complete the loading the ships generally proceed to Rangoon. Except for the foreshore shoal areas there are no obstructions or physical wrecks which interfere with commerce in the harbor area.

6. ANCHORAGES

Seven mooring buoys are maintained in the harbor area for the anchoring of large vessels. These buoys are of the light type with five-ton anchors and probably will have to be replaced with a larger type since difficulties are experienced by the larger vessels.

7. WHARVES AND JETTIES

There are five pontoon jetties of variable sizes, all in poor condition and in need of replacement. It is understood that four new pontoons are on order and will replace the old outmoded jetties on arrival. There are a great number of private wharves and jetties most of which are located at the rice mills along the river.

8. TRANSIT SHEDS AND WAREHOUSES

There are no public warehouses for general cargo. The State Agricultural Marketing Board rents or owns warehouses at eight different locations in the port area with a total storage capacity of about 43,000 tons. These storage units are scattered; two rented godowns are on the right bank of the river opposite the city and have a storage capacity of about 5,000 tons; three rented godowns are on the left bank of the river upstream of the city and have a capacity of about 7,800 tons; the godowns rented from the Anglo-Burma Company and the godowns at Wedaung are on the left bank downstream of the city and have a combined capacity of about 13,000 tons; three godowns scattered at various locations on the waterfront have a total capacity of 6,000 tons, and two godowns constructed by SAMB immediately upstream of the city have a combined storage capacity of about 11,000 tons. SAMB contemplates the early erection of a number of prefabricated warehouses, grouped with the warehouses rented from the Anglo-Burma Company and those at Wedaung, to form a major centralized rice storage unit at Bassein.

9. CARGO-HANDLING EQUIPMENT

There is no mechanical cargo-handling equipment at the Port of Bassein at present.

10. MARINE REPAIR

Except for small local private facilities for the repair of country boats the only facilities available are those of the port officer for minor repairs to his own craft and pilot launches and for repairs to jetties and aids to navigation buoys. For any major repairs the vessels are sent to the yards at the Port of Rangoon.

11. LABOR SUPPLY

Cargo handling at the Port of Bassein is accomplished entirely by coolie labor. There does not seem to be any shortage in this class of labor in the harbor area.

12. COMMERCE

The commerce of Bassein is basically the export of rice and rice products. There is virtually no foreign import general-cargo trade, and at present only a negligible tonnage of coastal import trade. In the ten years prior to the war the annual traffic in the Port of Bassein averaged 315,650 tons, with a high of 420,000 tons in fiscal year 1939–40. In the last four years the export of rice and rice products was 285,790 tons in 1949, in 1950 it was 208,056 tons, in 1951 it was 181,276 tons, and in 1952 amounted to 168,118 tons. The export in 1949 included a large amount of the storage from the previous year. The decreases in the following years probably are due to the reduction of paddy in cultivation as a result of insurgent activity. The tonnages of general cargo (coastwise) imported at the Port of Bassein were 1,179 tons in 1951 and 614 tons in 1952.

13. CARGO HANDLING

Because of the small amount of general-cargo trade at the Port of Bassein there are no problems connected with the handling of it. The basic commerce at the port is the export of rice and rice products. Out of the total export of about 168,000 tons in 1952, the amount shipped directly by lighters from mills to ships amounted to 104,800 tons or about 63%. During 1952 a total of 74,800 tons were delivered to the warehouses of SAMB and 63,270 tons were shipped out. Bagged rice is loaded from the warehouses direct to lighters and transported to the ships anchored in midstream. At present all delivery to warehouses is by country boats and lighters. After the rehabilitation and reopening of the railway from Henzada considerable commerce from the service area should be received at Bassein.

All handling of rice is by coolie labor and the SAMB storage units are near the river banks so the carrying distances are relatively short. The prevailing handling costs are:

	Per ton
Carrying of 100 bags of 210 lbs. from lighters to godowns, and stacking at K10.00/100	K1.07
Carrying of 100 bags of 210 lbs. from godowns to lighters at K9.50/100	K1.01
Lighters are rented by SAMB on monthly basis, average cost is about	K2.00
Total	K4.08

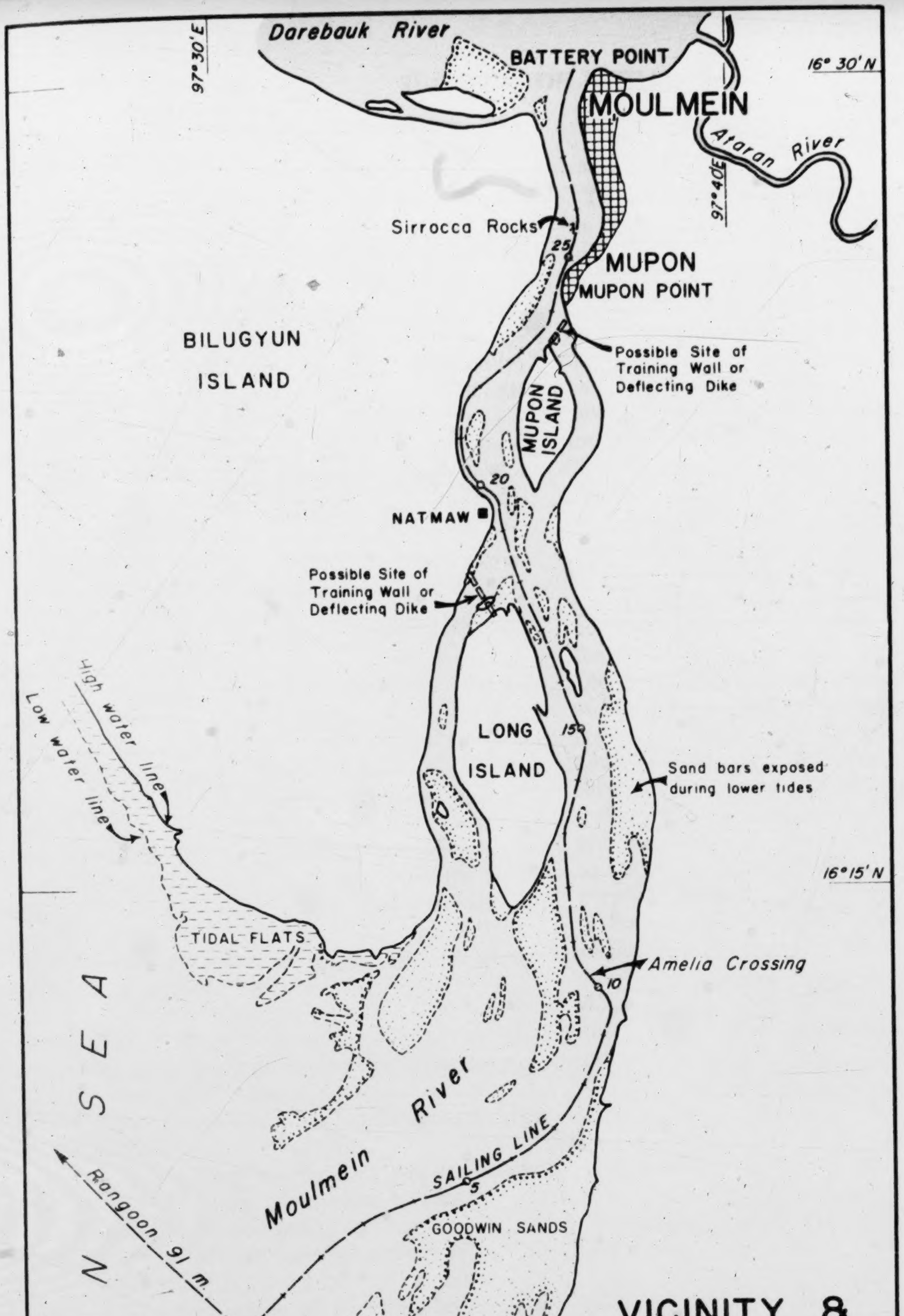
14. CONCLUSIONS

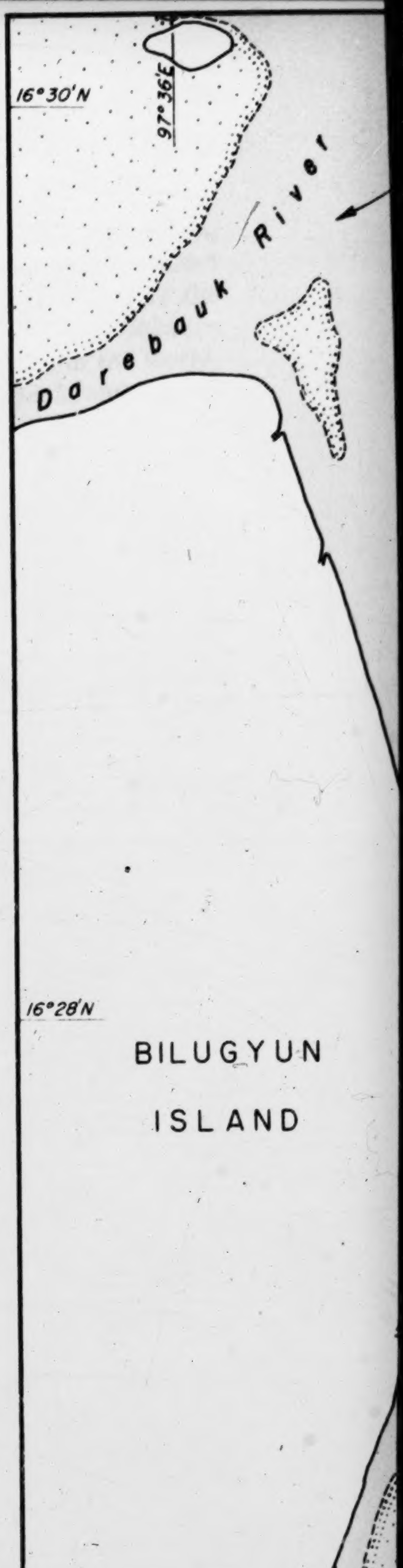
At the Port of Bassein there are no major requirements which have not been met or for which planning is not under way. The volume of general cargo is so small that its handling does not present any problems, and changes from the present methods of handling by coolie labor will not be justified. All State Agricultural Marketing Board warehouses of larger capacity are near the river banks, with the floor of the warehouses approximately at the same elevation as the deck of the jetties. It is considered that SAMB should investigate the possibility of connecting the jetties directly to the warehouses by trestles and using hand trucks or platform trucks to transport the rice bags from the warehouse directly to the jetty. Portable conveyors could be used for stacking of bags in warehouses.

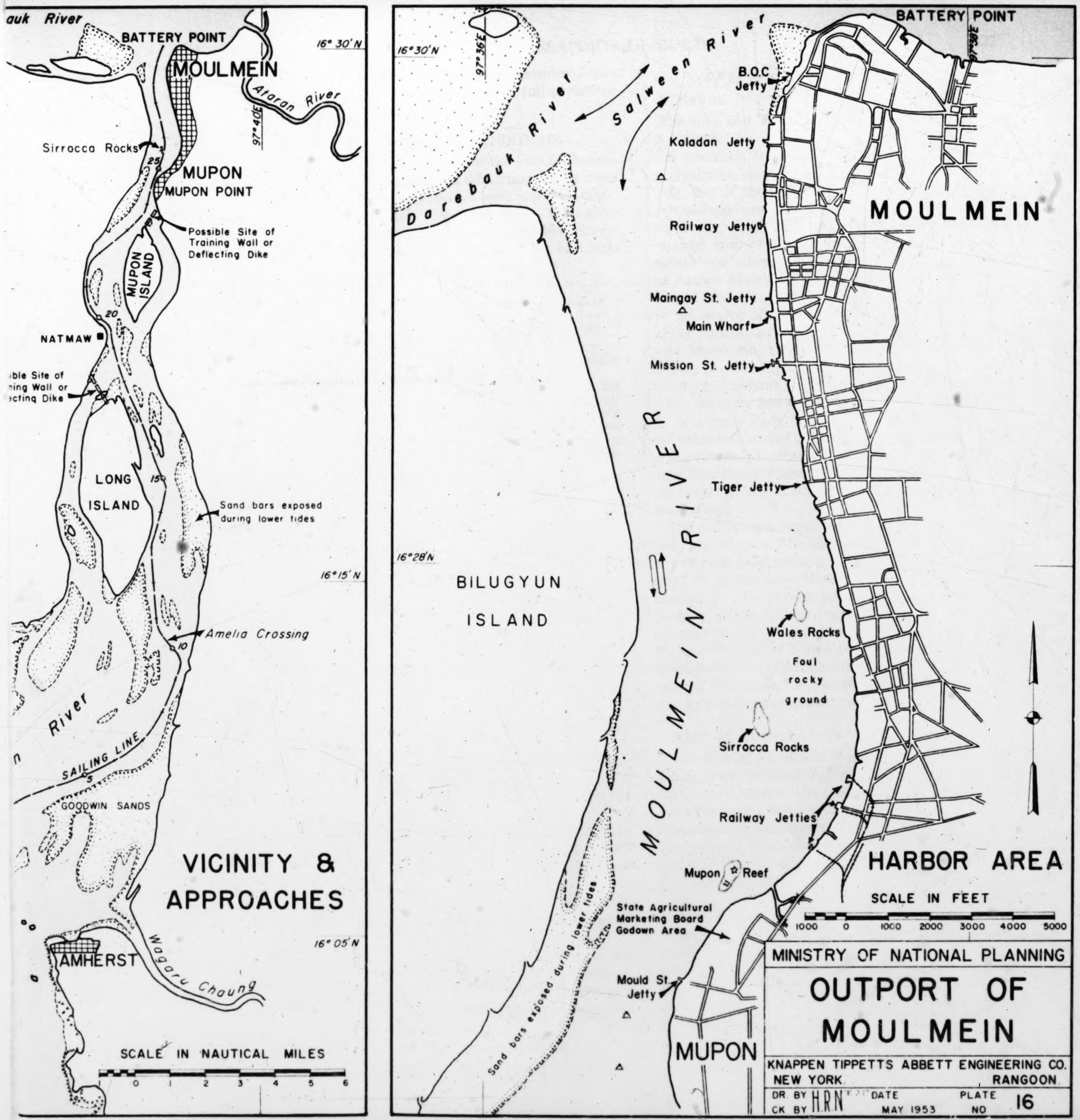
The present low tonnage of rice shipped from warehouses (about 63,000 tons in 1952), the dispersion of these warehouses at eight different locations along the waterfront, and the present low handling costs do not offer either a technical or economic justification for introduction of centralization of rice shipment; however the conditions will be different when the rice export again reaches and exceeds the prewar level and amounts to about 300,000 tons per year. Of this tonnage not more than 40 to 45% would be shipped from warehouses and it should be possible to direct about two thirds of warehoused tonnage, or about 100,000 tons, to the large group of warehouses, consisting of the Anglo-Burma Company and Wedaung godowns and of new warehouses to be constructed by SAMB at that location. To this group of warehouses the rice bags will be delivered by lighters, by rail from Henzada district, and by the highways leading into Bassein.

There are not many locations in Bassein for a wharf for sea-going vessels. It appears, however, that the river bank near the proposed group of godowns could serve the purpose and this location should be investigated. With a volume of about 100,000 tons handled annually from one location, the savings resulting from the elimination of lighterage, from shorter turn-around time of vessels, and from the mechanical handling of rice may justify economically the construction of a wharf.

With the completion of dredging at the proposed cutoffs and the easing of sharp bends in the entrance channel, much of the difficult navigation to the Port of Bassein will be eliminated. However, constant vigilance and maintenance dredging will be required at the bar and shoal sections to provide the safe navigating depths. These annual maintenance costs may be minimized through the use of river-training facilities and it would be prudent to investigate these possibilities through studies including hydraulic model tests.


VICINITY & APPROACHES
Darebauk River
97°30'E
BATTERY POINT
16° 30'N
MOULMEIN
Ataran River
97°40'E
Sirrocca Rocks
25
MUPON
MUPON POINT
BILUGYUN
ISLAND
Possible Site of
Training Wall or
Deflecting Dike
MUPON
ISLAND
20
NATMAW
Possible Site of
Training Wall or
Deflecting Dike
High water line
Low water line
LONG
ISLAND
15
Sand bars exposed
during lower tides
16° 15'N
TIDAL FLATS
Amelia Crossing
10
ANDAMAN SEA
Moulmein River
SAILING LINE
5
Rangoon 91 m
GOODWIN SANDS
Goodwin Lightship
Tavoy 190 m.
16° 05'N
AMHERST
Wagaru Chaung
SCALE IN NAUTICAL MILES
1
0
1
2
3
4
5
6


16°30'N
97°36'E
Darebauk River
16°28'N
BILUGYUN
ISLAND
Sand bars exposed during lower tides



VICINITY & APPROACHES

HARBOR AREA

auk River
BATTERY POINT
16° 30' N
MOULMEIN
Ataran River
97° 40' E
Sirrocca Rocks
25
MUPON
MUPON POINT
Possible Site of Training Wall or Deflecting Dike
MUPON ISLAND
20
NATMAW
ible Site of
ning Wall or
ecting Dike
LONG ISLAND
15
Sand bars exposed during lower tides
16° 15' N
Amelia Crossing
10
n River
SAILING LINE
5
GOODWIN SANDS
16° 05' N
AMHERST
Wagaru Chaung
SCALE IN NAUTICAL MILES
1 0 1 2 3 4 5 6
16° 30' N
97° 36' E
Salween River
Darebauk River
BATTERY POINT
97° 38' E
B.O.C Jetty
Kaladan Jetty
MOULMEIN
Railway Jetty
Maingay St. Jetty
Main Wharf
Mission St. Jetty
Tiger Jetty
16° 28' N
BILUGYUN ISLAND
MOULMEIN RIVER
Wales Rocks
Foul rocky ground
Sirrocca Rocks
Railway Jetties
Mupon Reef
11
State Agricultural Marketing Board Godown Area
Sand bars exposed during lower tides
Mould St. Jetty
MUPON
SCALE IN FEET
1000 0 1000 2000 3000 4000 5000

MINISTRY OF NATIONAL PLANNING

OUTPORT OF MOULMEIN

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK, RANGOON

DR BY HRN
CK BY
DATE MAY 1953
PLATE NO 16

With an increase in commerce it is considered that night navigation will be required to take full advantage of on-tide navigation.

15. ESTIMATED REQUIRED EXPENDITURES

The estimated expenditures for the Port of Bassein are as shown in the following tabulation. These costs have been separated into foreign costs and local costs: foreign costs represent the expenditures for equipment, supplies and materials not available locally; local costs are the expenditures for labor, materials and supplies available in Burma.

	Foreign Costs (K)	*Local Costs (K)*	*Total Costs (K)*
Service craft and pilot vessels	6,75,000	75,000	7,50,000
Maintenance equipment (prorated)	13,50,000	1,50,000	15,00,000
River dredging and cutoffs	1,00,000	24,00,000	25,00,000
Navigation aids	13,50,000	1,50,000	15,00,000
Hydraulic model tests	1,00,000	25,000	1,25,000
Cranes	90,000	10,000	1,00,000
Dockyards	7,500	17,500	25,000
Total	36,72,500	28,27,500	65,00,000

The recommended improvements and expenditures should be made in the next five fiscal years. Since the dredging and installation of navigational aids should be in the first two years, the expenditures for those periods will be large. The recommended annual expenditures are K27,00,000 for the first year, K24,50,000 for the second year, and K4,50,000 for each of the following three years.

16. RECOMMENDATIONS

In summary, with respect to the Port of Bassein, it is recommended that:

(*a*) The use of coolie labor to handle general cargo be continued.

(*b*) SAMB investigate the possibility of connecting the jetties directly to the warehouses by trestles, and of using hand or platform trucks to transport the rice bags from the warehouse directly to the jetty.

(*c*) Centralization of rice shipment be planned, to consist of the construction of the proposed SAMB warehouses and a wharf for seagoing vessels adjacent to the proposed warehouses.

(*d*) Dredging be completed at the proposed cutoffs, and that the sharp bends in the entrance channel be eased.

(*e*) Maintenance dredging be continued at the bar and shoal areas to provide safe navigating depths.

(*f*) Hydraulic model tests be initiated to investigate possible use of river-training facilities to minimize annual maintenance.

E. PORT OF MOULMEIN

1. GENERAL

The City and Port of Moulmein are located on the Salween River, beginning at a point about 24·5 miles upstream from the Goodwin Light where the river empties into the Andaman Sea. The Salween River, one of the largest river systems in the world, flows through country abounding in teak, and rafts of this product are floated to the mills at Moulmein. In the tidal area of the Salween and its downstream navigable tributaries, the Donthami, the Gyaing and the Ataran Rivers, in a semi-circular area of 50- to 70-mile radius, are the productive paddy lands which are the source of the rice commerce. There are also rubber plantations in the Moulmein area.

At Moulmein, the Salween River splits into two outlets; one flowing westward to the Andaman Sea is called the Darebauk River and is navigable to country boats, the other flowing southward to the sea is called the Moulmein River and is the commercial waterway and entrance channel to the port. The mean river level at Moulmein is highest in September when it is about eight feet above Mean Low Water Springs datum, and lowest in March when it is about three feet above this datum.

The main commerce of the Port of Moulmein is rice and rice products. The annual rice export of the port as well as its total traffic is the third largest among the seaports of Burma, following that of Rangoon and Bassein. In the prewar period Moulmein averaged over 4% of the foreign trade of Burma; and, in the postwar period this commerce has increased to about 5%. Nearly 15% of Burma's coasting trade is handled through the Port of Moulmein. Plate 16 entitled "Outport of Moulmein" shows the pertinent features of the port and entrance channel.

2. PORT ADMINISTRATION

The Port of Moulmein is under the general supervision of the Nautical Adviser and Principal Officer, Mercantile Marine Department of the Ministry of Transport and Communications. However, as the port is operated on local funds, final decision on the utilization of these funds rests with the local Port Officer and the District Commissioner, guided by a local Port Advisory Board.

3. WAR DAMAGE AND REHABILITATION

The city and port of Moulmein were subjected to heavy bombing by the Allied Forces during the past war, but the city suffered the greater damage. At the port four pontoons, two bridges, and the godowns were lost. The damaged structures at the port have been removed. The rehabilitation and replacement of war-damaged installations either have been completed or are in the process of completion.

4. ENTRANCE CHANNEL

The bed of the Moulmein River is of the alluvial type, thus the navigation channel both in the bay and river sections is subject to constant change. However, under the same general average annual hydraulic conditions, depths and widths of the navigation channel should maintain the same relative values even though there may be considerable side movement of the channels. Numerous hydrographic surveys are required to maintain channel alignment delineation.

In general, the lower 10·5 miles of the waterway above Goodwin Light can be considered as the bay section, varying in width of favorable depths from over 6,000 to 1,700 ft. Depths vary from about 20 to 57 ft. Mean Low Water Springs datum. In the remaining 14 miles to the port of Moulmein depths vary from 20 to 60 ft. MLWS datum, and widths vary from 400 to 1,600 ft.; however, there are critical sections where depths decrease to 11·5 ft. MLWS and widths to as low as 200 ft.

In addition to the numerous isolated rock shoals there are three sections of critical navigation in the Moulmein channel. The first section is at the Amelia Crossing, from 11 to 11·5 nautical miles above Goodwin Light, where deep water suddenly changes from the east to the west side of the river. At this abrupt cross-over, shoals exist in the centre of the river. At Natmhaw, about 19 miles above Goodwin Light, there are serious rock shoals and also abrupt alignment changes in two very sharp curves. In the vicinity of Mile 22, or about 2·5 to 3·5 miles above Natmhaw, there is another shoal area and section of rather sharp reverse curvature. For the remaining sections of the Moulmein River the depths are in excess of the above critical sections. The critical depths under the different tidal conditions, as sounded in December 1951, were:

	Tidal stage in feet			
	MLWS	*MLWN*	*MHWS*	*MHWN*
Amelia Crossing	12·5	18·5	31·5	26·0
Natmhaw vicinity	21·0	24·0	36·2	31·0
Mile 22	11·5	12·5	25·0	19·5

In general, the widths of the Moulmein River navigation channel are adequate for seagoing vessels; however, the numerous rock shoals and the three mentioned critical sections require good pilotage and cautious navigation. There are no wrecks to interfere with safe navigation.

The Moulmein Channel was mined extensively by the Allied Forces during the war. As an initial step toward the reopening of the port for commerce the navigation channel was swept. Because of the shifting nature of this channel, drafts of the vessels were restricted to 22·5 ft. by the mine conditions. Early in 1953 the mined and unswept areas were declared by Government safe for navigation; however, it is questionable whether it would be advisable to undertake dredging or other construction work prior to the removal or detonation of the remaining mines.

5. HARBOR AREA

Moulmein harbor is considered to be the section of the Moulmein River between Mupon Point and Battery Point, a river frontage of about four nautical miles, beginning about 24·5 nautical miles upstream of Goodwin Light; however, the lower mile of the harbor is not suitable for anchorage because of the Sirrocca Rocks shoals.

The anchorage area in Moulmein River opposite the city has depths of 22·5 to 25·5 ft. MLWS datum; the depths of the anchorage area opposite Mupon Point, downstream from Moulmein, vary from 36·5 ft. to 53·5 ft. MLWS. Adequate depths are not available close enough inshore to permit the loading or unloading of vessels from existing wharfage facilities and the cargoes are lightered to and from ships anchored in midstream. Rice ships generally are loaded with about 3,000 tons of cargo while in the harbor; whenever necessary loading to deeper drafts is then completed in the estuary about 21 miles below Moulmein, but loading there is difficult during monsoon season as the moorings are easily swept away. The Sirrocca Rocks shoals limit the anchorage areas at the port. One of the early phases of waterway modifications which would be required by the use of larger ships and increased commerce requirements would be the removal of these shoals. Other sections of alluvial shoals are in the harbor area and also would require removal. There is no wreckage in the harbor area which adversely affects navigation.

6. ANCHORAGES

Seven mooring buoys are maintained in the harbor area for the anchoring of large vessels. Two additional buoys are being furnished through the United States ECA/TCA assistance program but have not yet been delivered.

7. WHARVES AND JETTIES

There are five principal pontoon jetties for public use, two for the use of harbor craft, and a jetty as the terminal for the Burma Railways ferry service between Martaban and Moulmein. The principal jetty is called

Mission Jetty and is located at the south end of Strand Road. It is a temporary structure of 16 sectional pontoons; however, it is to be replaced in 1953 by a 40 ft. by 250 ft. pontoon which was furnished through the ECA TCA program and which is now being fabricated at Rangoon. At the Mission Jetty there is a platform supported on steel piles and extending out from shore which supports a sheet-metal shed for general cargo. There are several small private wharves and timber jetties, mostly at the rice mills and sawmills. They are not available for general-cargo handling.

8. TRANSIT SHEDS AND WAREHOUSES

There are two small godowns for general cargo, one located at the Mission Jetty and one at the jetty in the upper section of the harbor. The State Agricultural Marketing Board has two rice warehouses at Mupon with a combined storage of about 6,000 tons. SAMB has completed recently warehouses at Martaban with a combined rice storage capacity of about 18,000 tons.

9. CARGO-HANDLING EQUIPMENT

There is no mechanical cargo-handling equipment at the Port of Moulmein at present.

10. MARINE REPAIR

The Inland Water Transport Board maintains two separate shipways at Moulmein. At present the repairs to all harbor craft are made by IWTB on these shipways; however, there is included in the planning of the Mercantile Marine Department the installation of a separate boatyard. The present facilities of the port officer are only adequate for the repair to the aids to navigation.

11. LABOR SUPPLY

Cargo handling at the Port of Moulmein is accomplished entirely by coolie labor. There appears no shortage of that type of labor in the Moulmein area.

12. COMMERCE

From 1924 through 1941 the commerce at the Port of Moulmein averaged about 168,000 tons per year, varying from a low of 134,250 tons in fiscal year 1925–26 to a high of 254,000 tons in fiscal year 1939–40. The maximum export of rice and rice products was about 168,000 tons in 1938. In the last four years the export of rice has been about 105,000 tons in 1949, about 91,800 tons in 1950, about 100,500 tons in 1951 and about 103,800 in 1952. The tonnages of other exported and imported products, in foreign and coastwise trade, composed principally of the export of teak, rubber and general cargo, and import of coal, petroleum, general cargo and other products, are as follows:

	1951			*1952*		
	Sea-borne	*Coast-wise*	*Total*	*Sea-borne*	*Coast-wise*	*Total*
Exports	1,028	24,976	26,004	25,327	not available	
Imports	7,469	26,758	34,227	34,855	not available	
Total	8,497	51,734	60,231	60,182	not available	

13. CARGO HANDLING

No mechanical equipment is available at present and all general-cargo handling is by hand with coolie labor. Ocean-going vessels are moored in midstream and all cargo is lightered to and from the jetties. The only exception is the S.S. *Matang*, a vessel of 1,469 gross tons of Straits Steamship Company. This ship calls on the Tenasserim ports, making a round trip between Rangoon and Penang once in about every 3 weeks. It has a draft of about 11 ft. and berths directly at the Mission Jetty at the Strand Road. All cargo handling takes place at the Strand Road, congesting the latter and obstructing street traffic.

All exported rice is transported by lighters and barges from the warehouses or directly from the rice mills to the ships anchored in midstream. The warehouses at Martaban receive bagged rice from the mills which are located in the area along the right bank of the Salween River; the warehouses at Mupon receive rice from the area to the east and southeast of Moulmein. Delivery to both groups of warehouses is mostly by truck with a small tonnage arriving by rail. The annual tonnage shipped from Martaban averages about 30,000 tons, or about 30% of the total annual export; shipments from Mupon do not exceed 7,000 to 10,000 tons per year, or about 7 to 10% of the total annual export. About 35 to 40% of export rice is shipped from the warehouses at present, and 60 to 65% is shipped directly from mill storage by lighters and barges.

All handling of rice is by coolie labor and the warehouses all are relatively near the river banks, so the carrying distances are short. Bags weighing 160 lbs. each are used generally because the predominantly Burmese labor finds it difficult to handle the larger bags. The prevailing handling rates at Mupon are:

	Per ton
Carrying of 100 bags of 160 lbs. from trucks to godowns and stacking at K9.00/ton	K1.26
Carrying of 100 bags of 160 lbs. from godowns to lighters at K13.00/ton	K1.82
Lighterage to ship's side in harbor	K5.00
Lighterage to ship's side in estuary	K7.50
Stevedore's slinging charge, in harbor	K0.56
Stevedore's slinging charge, in estuary	K0.75
Total costs of handling, from truck to f.o.b. ship, in harbor	K8.64
Total costs of handling from truck to f.o.b. ship, in estuary	K11.33

14. CONCLUSIONS

At the Port of Moulmein either most of the immediate outstanding requirements are being accomplished or the planning for their early execution is under way. At this time the Moulmein River is being dredged, and during these operations it is planned to remove as much of the rock shoals as practicable. However, maintenance dredging in this port entrance channel always will be a major problem because of the silt load of the Salween River and the meandering nature of the river bed. The use of training walls should minimize this dredging to a large extent and hydraulic studies should be made of the effect of walls or deflecting dikes as shown on Plate 16.

Through the assistance of the United States ECA/TCA program 18 lighted buoys were furnished as aids to navigation in the Moulmein entrance channel. It is recommended that the remaining buoys be replaced progressively and supplemented with necessary markers and night tide gauges for night navigation.

As indicated in paragraph 16 g(4), section B of this chapter (Port of Rangoon) there should not be a duplication of marine repair facilities in any one port. At the Port of Moulmein all marine repair facilities should be consolidated into one efficient unit under the direction and operation of the Department of Yards and Docks.

General-cargo commerce is not of adequate tonnage to warrant or justify the installation of expensive wharves and transit sheds; however, following the installation of the new cargo jetty now being assembled at Rangoon consideration should be given to either the extension of the present marginal platform or to its replacement with a larger one to eliminate the necessity of handling the commerce on Strand Road.

The two groups of rice warehouses (at Martaban and at Mupon) cannot be combined as they serve the mills located on opposite sides of the Salween River. The draft conditions to Martaban do not permit the construction of a wharf from which rice bags could be loaded directly in the ships. Furthermore, the small tonnage of rice shipped from warehouses and low labor costs at Moulmein would not justify economically the introduction of central warehousing and mechanical rice loading. The use of hand or platform trucks for the transport of bags from the godowns at Martaban to the end of the jetties should be considered.

15. ESTIMATED REQUIRED EXPENDITURES

The estimated expenditures for the Port of Moulmein are as shown in the following tabulation. These costs have been separated into foreign costs and local costs: foreign costs represent the expenditures for equipment, supplies, and materials not available locally; local costs are the expenditures for labor, materials and supplies available in Burma.

	Foreign Costs (K)	*Local Costs (K)*	*Total Costs (K)*
Service craft and pilot vessels	6,75,000	75,000	7,50,000
Maintenance equipment (prorated)	15,75,000	1,75,000	17,50,000
River dredging and cutoffs	50,000	14,50,000	15,00,000
Navigation aids	4,50,000	50,000	5,00,000
Hydraulic model tests	1,20,000	30,000	1,50,000
Cranes	4,50,000	50,000	5,00,000
Dockyards	60,000	1,40,000	2,00,000
Total	33,80,000	19,70,000	53,50,000

The recommended improvements and expenditures should be accomplished in the next five fiscal years. Since the dredging and installation of navigational aids should be in the first three years, the expenditures for those periods will be large. The recommended annual expenditures are K16,25,000 each for the first and second years, K11,00,000 for the third year, and K5,00,000 for each of the following two years.

16. SUMMARY OF RECOMMENDATIONS

In summary, with respect to the Port of Moulmein, it is recommended that:

(*a*) Hydraulic studies be initiated to determine the practicability of using training walls to direct the river flow and minimize the dredging.

(*b*) The buoy system for the entrance channel be revised to permit night navigation.

(*c*) Marine repair facilities be consolidated into one unit under the direction and operation of the proposed Department of Yards and Docks.

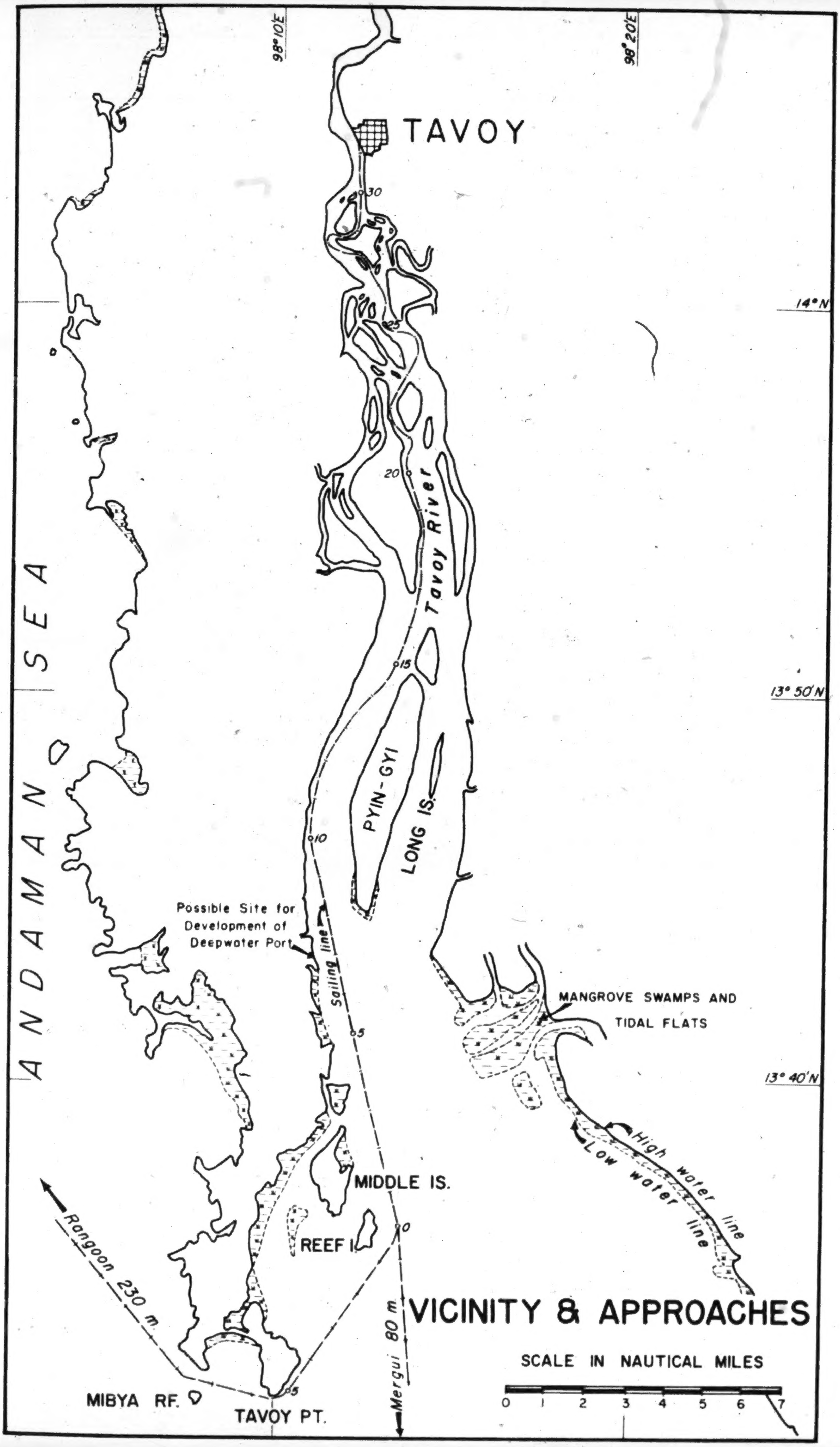
(*d*) The present marginal platform be extended or replaced with a larger one to eliminate the handling of commerce on Strand Road.

(*e*) The use of hand or platform trucks for the transport of bags from the godowns at Martaban to the end of the jetties be considered.

F. PORT OF TAVOY

1. GENERAL

The Port of Tavoy is one of the minor seaports of Burma. The City and Port of Tavoy are located on the Tavoy River about 35 nautical miles from deep-water and about 32 miles upstream of Reef Island light, the beacon designating the entrance to the waterway. For sea-going vessels the waterway is navigable for a distance of about 7·5 miles above Reef Island. However,



VICINITY & APPROACHES

98°10'E
98°20'E
TAVOY
30
14°N
25
20
Tavoy River
15
13° 50'N
PYIN-GYI
LONG IS.
10
A N D A M A N   S E A
Possible Site for
Development of
Deepwater Port
Sailing line
5
MANGROVE SWAMPS AND
TIDAL FLATS
13° 40'N
High water line
Low water line
MIDDLE IS.
REEF I.
0
Rangoon 230 m
Mergui 80 m
MIBYA RF.
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TAVOY PT.
SCALE IN NAUTICAL MILES
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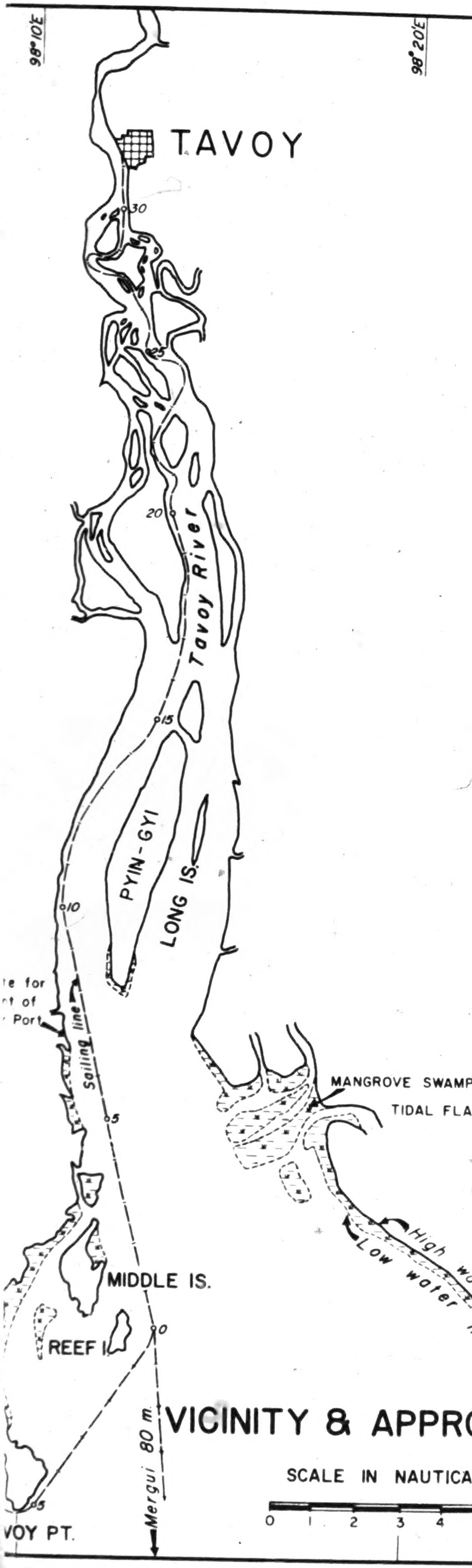
water line
water line


98° 10'E
98° 20'E
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Tavoy River
PYIN-GYI
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Sailing line
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TIDAL FLA
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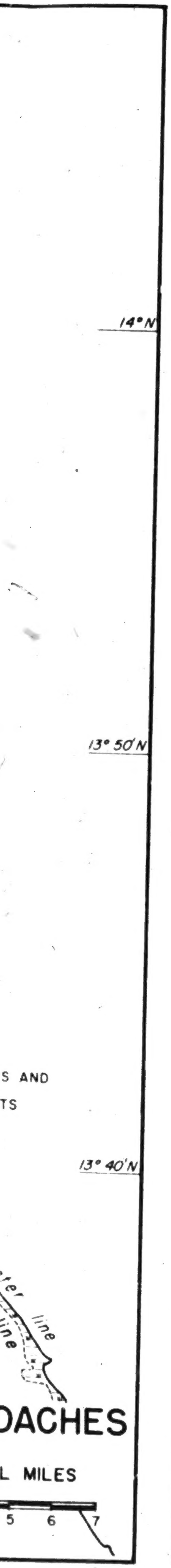
14° N
13° 50'N
13° 40'N
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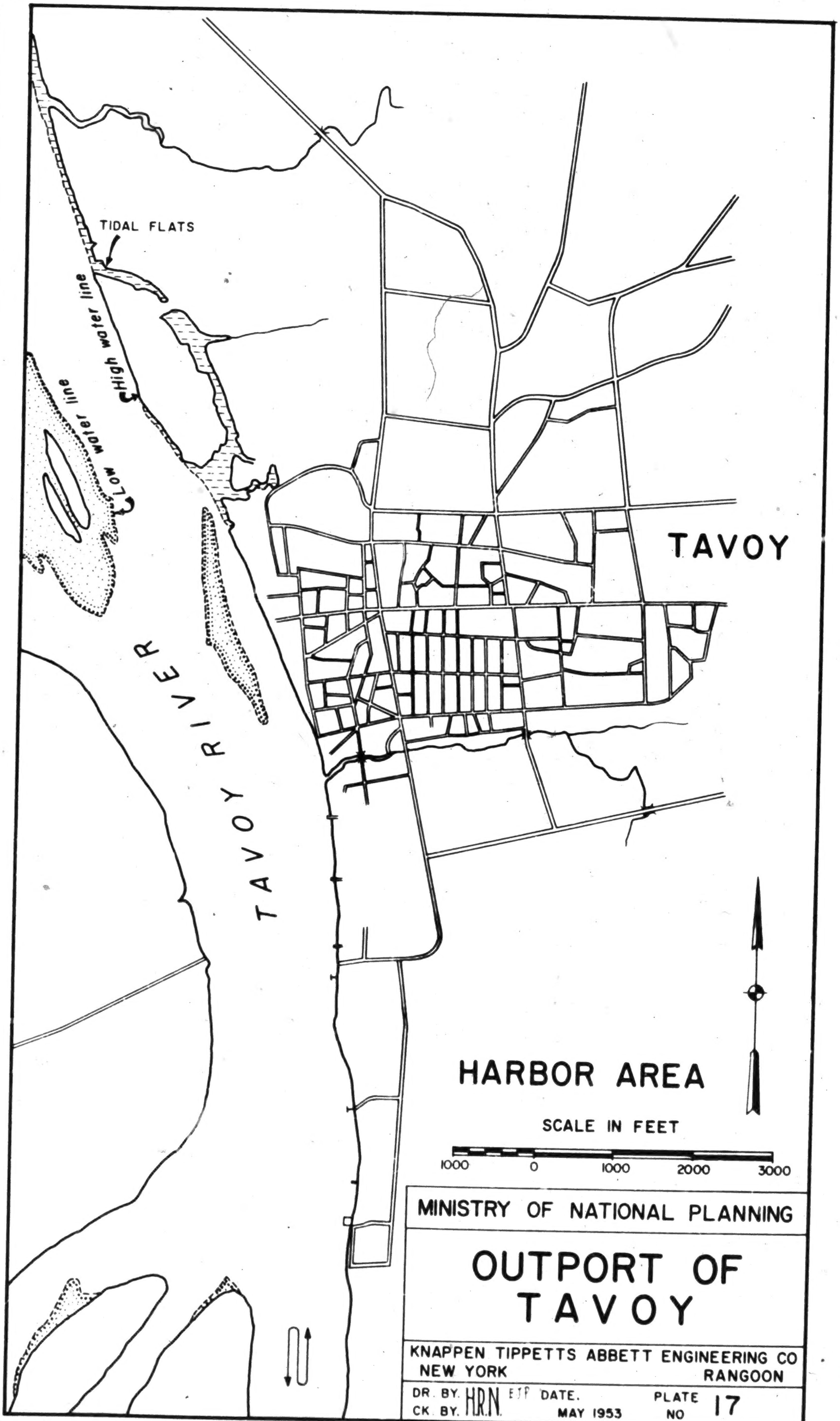

TIDAL FLATS
High water line
Low water line
TAVOY RIVER
TAVOY
HARBOR AREA
SCALE IN FEET
1000
0
1000
2000
3000

MINISTRY OF NATIONAL PLANNING

OUTPORT OF TAVOY

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON

DR. BY. HRN DATE. PLATE
CK. BY. ETP MAY 1953 NO 17

ships seldom proceed or anchor beyond the series of rock shoals, which begin about 1·5 miles farther downstream and extend to about four miles above Reef Island. The river permits navigation by launches and country boats only, and all transfer of cargo is accomplished at the anchorages through lightering. Plate 17 entitled "Outport of Tavoy" shows the pertinent features of the port and entrance channel.

The Port of Tavoy at present handles a little over 1% of Burma's total foreign trade and nearly 5% of the coasting trade.

2. PORT ADMINISTRATION

The Port of Tavoy is under the general supervision of the Nautical Adviser and Principal Officer, Mercantile Marine Department of the Ministry of Transport and Communications. However, as the port is operated on local funds, the final decision on the utilization of these funds rests with the local District Commissioner. There is no port officer assigned to Tavoy.

3. WAR DAMAGE AND REHABILITATION

While the City and Port of Tavoy were subjected to considerable damage from bombing by Allied Forces during the war there remains very little riverside damage requiring further repair. No other rehabilitation measures need be accomplished for navigation and transport reasons.

4. ENTRANCE CHANNEL

From Reef Island to the anchorage area the minimum depth is approximately 29 ft. Mean Low Water Springs datum, 45 ft. MHWS or 40 ft. MHWN. In the anchorage area the widths are of large magnitude and to this point there would be no navigational difficulties. From the anchorage area to Tavoy the river is very sinuous, shallow, and difficult to navigate even with small local craft. While depths will vary from 6 to 24 ft. MLWS, 22 to 40 ft. MHWS, and 17 to 35 ft. MHWN, making it possible for some vessels to transit the river under high-tide conditions, because of the sinuousity of the channel, shifting channels in the alluvial bed and obstructions, it is inadvisable to attempt to navigate the river with any craft except small motor craft, barges and sampans. Furthermore, depths at Tavoy during low-tide conditions are as small as two feet, thus eliminating suitable anchorage.

During the war the entrance to the Tavoy River as far upstream as eight nautical miles above Reef Island was extensively mined by the Allied Forces. While the seaward channel has been swept thus permitting safe access to the anchorage area, the mines still can be considered as active and subject to detonation during dredging or striking with anchors. Before any dredging or other construction operations are undertaken, it would therefore be advisable to remove or detonate the mines.

The only obstructions in the Tavoy River estuary are the rock shoals at about four nautical miles and at six to seven miles above Reef Island. Were these shoals removed, free access would be available to vessels as far as about 11 miles above Reef Island. However, the benefits of the additional five miles of waterway would hardly be commensurate with the cost and no particular advantage to shipping would be obtained.

5. HARBOR AREA

The harbor and anchorages for seagoing traffic are in the Tavoy River estuary described in the preceding discussion. Depths, widths and anchorage areas are adequate. The Port of Tavoy at the city proper is limited entirely to shallow-draft and local riverine traffic. Depths at Tavoy are variable and may be as low as two feet during low tide. While the watershed of the Tavoy River is relatively small in area it is located in a zone of extremely heavy rainfall, thus excessive river currents are present in the harbor during and immediately following the monsoon season.

6. FACILITIES AND LABOR

There are no mooring buoys either at Tavoy or in the estuary anchorage area. There are no commercial wharves, public warehouses, facilities for storage of general cargo, or mechanical facilities for handling of general cargo at Tavoy. There are numerous private wharves for loading sampans and barges, principally in connection with the rice mills. All storage facilities are private and appurtenant to the rice mills. The only marine repair facilities available are small yards capable of repairing country craft only. Cargo handling is accomplished entirely by coolie labor. There does not appear to be any shortage in this class of labor.

7. COMMERCE

Prewar statistics on waterborne commerce at Tavoy are not available, but it is known that the principal commodities exported included rice and rice products, timber, charcoal, dried betel nut, tin and wolfram ore, dried fish and rubber. Principal imports include machinery parts, sugar, textiles, oil, tinned provisions, stationery, grocery goods, sundry products, and petroleum, oil and lubricants.

The following figures of seagoing and coastwise commerce, are the most recent recorded:

	1949–50 *tons*	*1950–51* *tons*
Exports		
Rice and Rice Products	2,557	11,285
Wolfram, Rubber, Tin, etc.	9,326	9,800
Total Exports	11,883	21,085
Imports		
General Cargo	7,126	8,917
Total Commerce	19,009	30,002

Since the Port of Tavoy serves a rather restricted area of low potential agricultural use the future tonnages in agricultural and forestry products, including rubber, probably will continue low. Any appreciable increase in export commerce will depend on the development of natural resources and minerals in the trade area.

8. CARGO HANDLING

All cargo handling is accomplished by coolie labor and lighterage in the estuary anchorage area. The lighters are loaded at Tavoy from the local piers and jetties and towed on tide to the deep-water anchorage area. In view of the small amount of commerce changes in handling procedure are not immediately warranted.

9. CONCLUSIONS

In the Port of Tavoy there are no major outstanding rehabilitation requirements which have not been completed or for which planning is not under way. In the Tavoy channel much difficulty is experienced by the launches and country boats and the alleviation of these conditions would be desirable. The rock shoals in the anchorage areas could be removed; however, not more than minor maintenance dredging is warranted under present trade conditions. Since the river channel is alluvial and meandering there is the possibility that much of the unsatisfactory conditions could be alleviated by use of training walls. Another solution would be to establish warehouses and jetties at deep water and connect with Tavoy by railway and highway. Engineering investigations and analyses of these possibilities need be undertaken only when the volume of commerce at Tavoy increases substantially, or when time permits as a good housekeeping measure.

10. ESTIMATED REQUIRED EXPENDITURES

The estimated expenditures for the Port of Tavoy are as shown in the following tabulation. These costs have been separated into foreign costs and local costs. Foreign costs represent the expenditures for equipment, supplies and materials not available locally. Local costs are the expenditures for labor, materials and supplies available in Burma.

	Foreign Costs (K)	*Local Costs (K)*	*Total Costs (K)*
Service craft and pilot vessels	2,25,000	25,000	2,50,000
Maintenance equipment (prorated)	2,25,000	25,000	2,50,000
Channel and port clearance	10,000	2,40,000	2,50,000
Navigation aids	45,000	5,000	50,000
	5,05,000	2,95,000	8,00,000

The recommended improvements and expenditure should be accomplished in the next five fiscal years at the rate of K2,75,000 the first year, K2,25,000 the second year and K1,00,000 for each of the following three years.

11. SUMMARY OF RECOMMENDATIONS

In summary, with respect to the Port of Tavoy, it is recommended that:

(*a*) The rock shoals in the anchorage areas be removed.

(*b*) The use of training walls to minimize dredging be investigated by model studies.

(*c*) The establishment of warehouses and jetties at deep-water with connections to Tavoy by railway and highway be investigated.

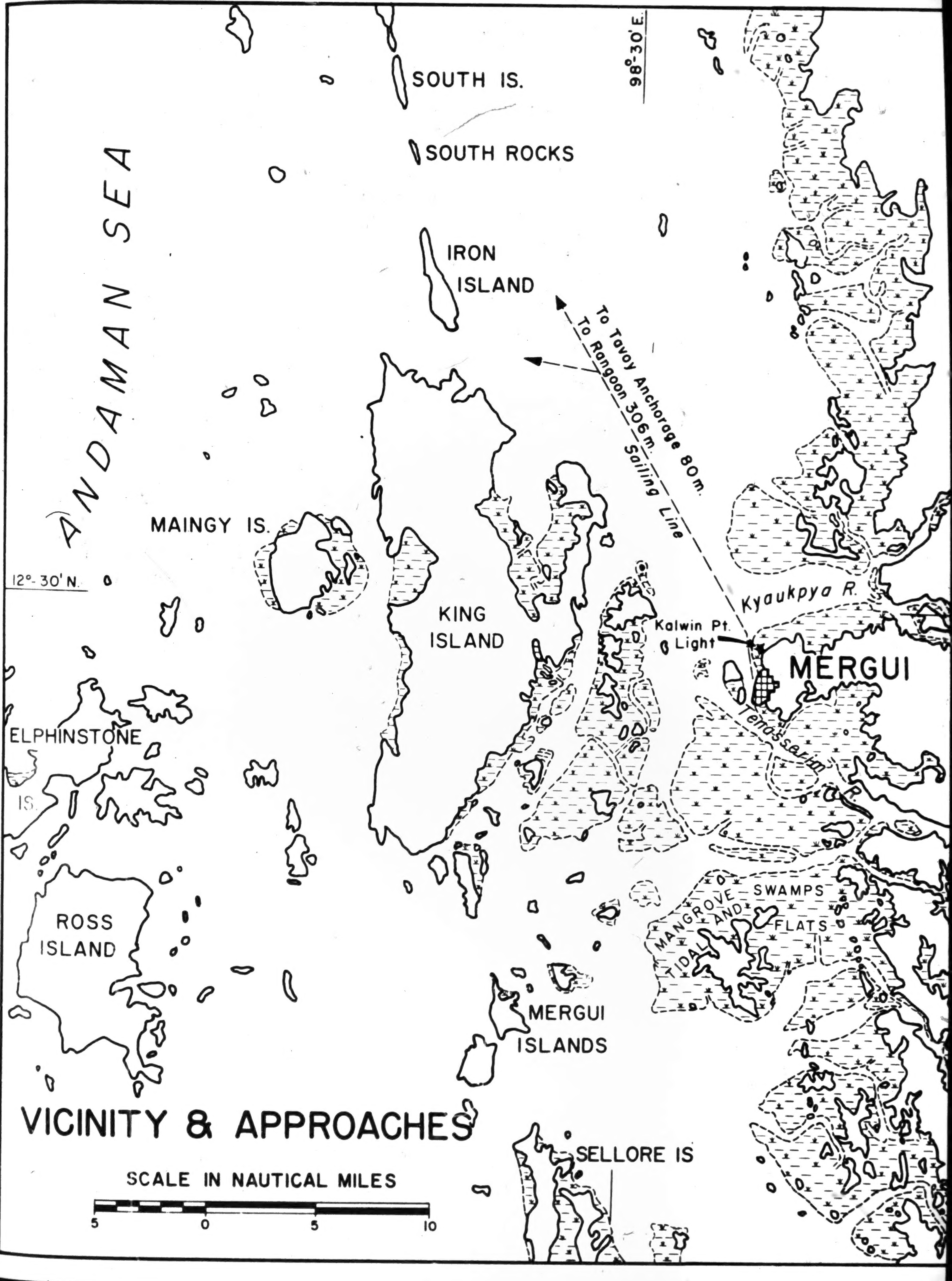
G. PORT OF MERGUI

1. GENERAL

The Port of Mergui is located on a tidal cutoff connecting the mouths of the Great Tenasserim and Kyaukpya Rivers. The north entrance to the channel serves as access for seaborne traffic, the south entrance serves principally the Great Tenasserim River. Along the navigation course the distance from the harbor to deep-water at sea is about four nautical miles.

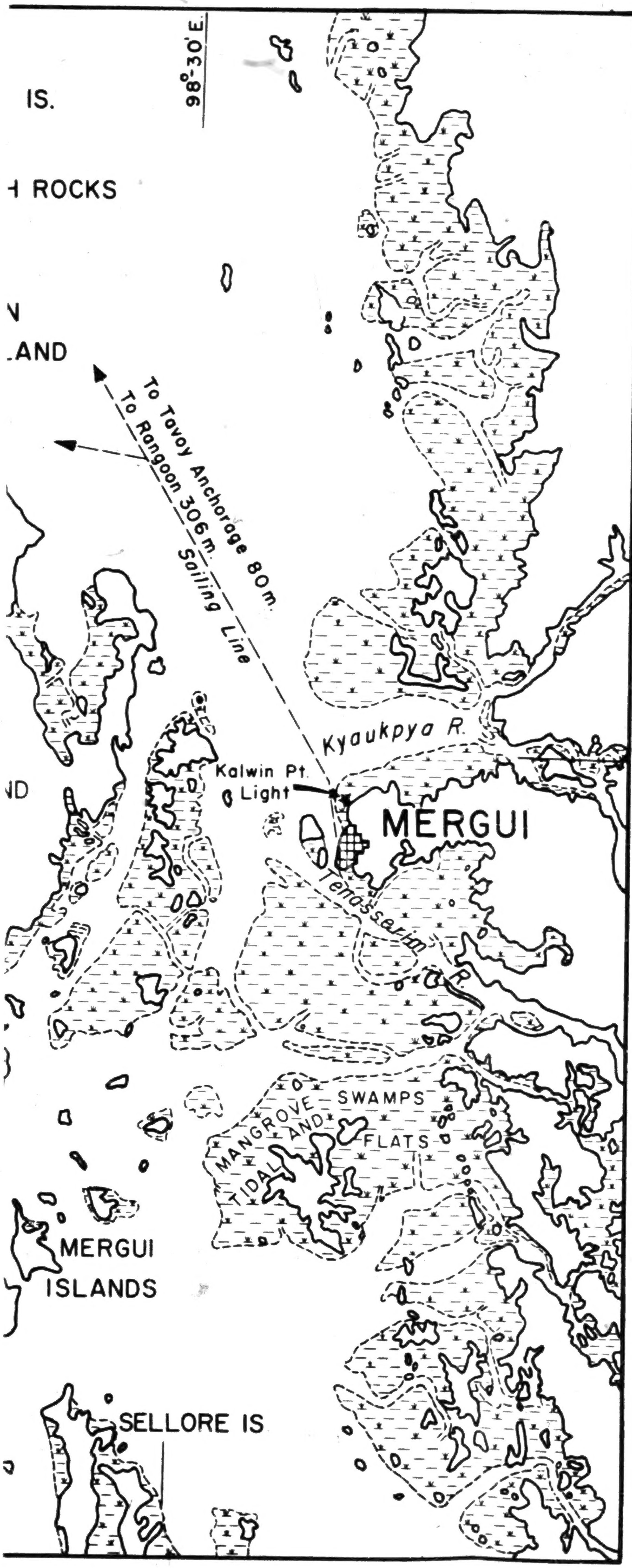
The Port of Mergui is considered as the section of the channel opposite the entire city, a distance of a little over one nautical mile. The bank at the city waterfront is protected by a revetment of large stones for a length of approximately 4,000 ft. This revetment is referred to locally as a seawall. Plate 18 entitled "Outport of Mergui" shows the pertinent features of the port and entrance channel.

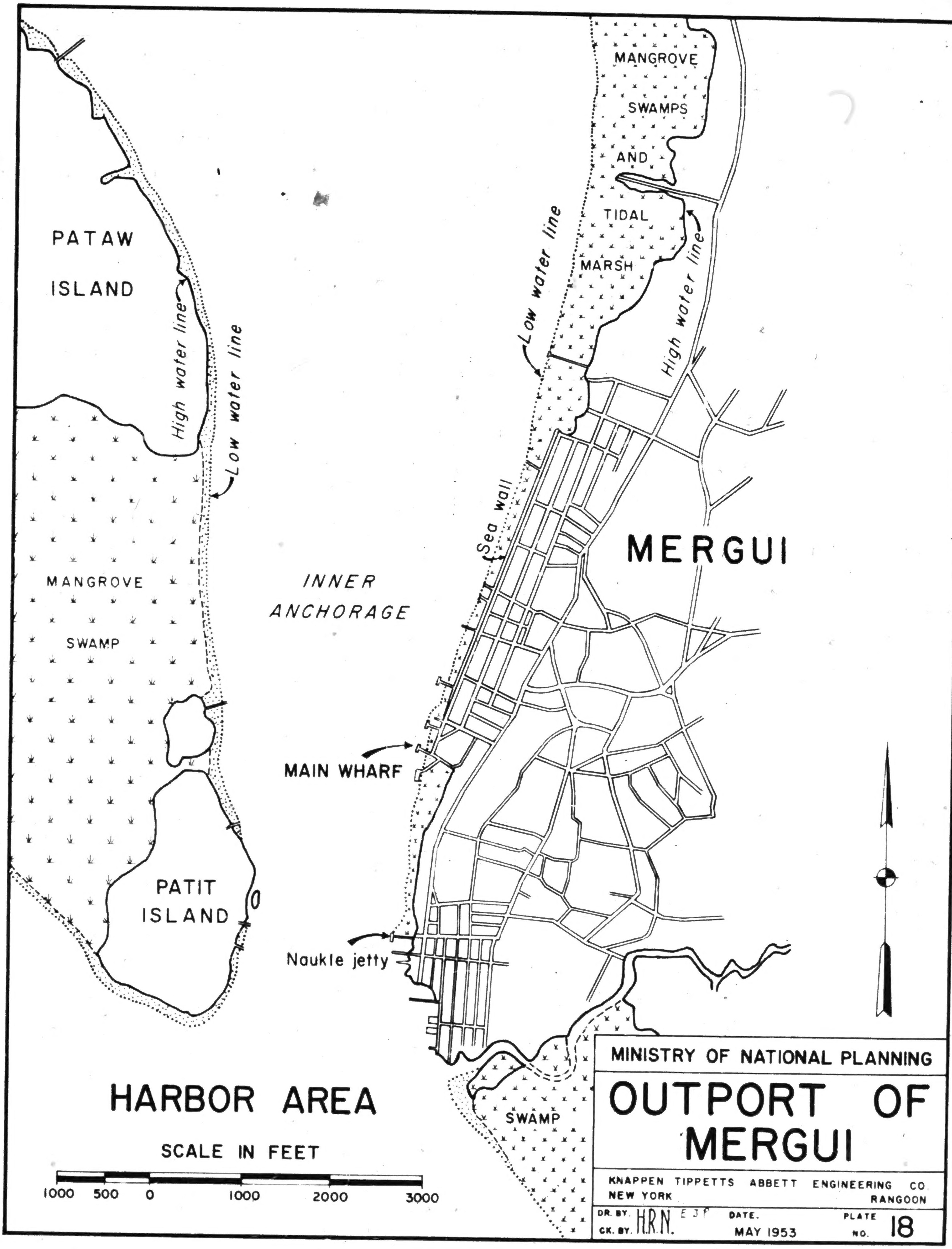
In the prewar period the Port of Mergui handled a negligible amount of the foreign trade of Burma. In the postwar period it still has less than 1%. Exceeded only by the Port of Rangoon, the Port of Mergui now plays an important role in the coasting trade, handling nearly 21% of all of the country's coasting commerce.



SOUTH IS.
98°-30'E.
SOUTH ROCKS
ANDAMAN SEA
IRON ISLAND
To Tavoy Anchorage 80m.
To Rangoon 306m.
Sailing Line
MAINGY IS.
12°-30'N.
KING ISLAND
Kyaukpya R.
Kalwin Pt. Light
MERGUI
Tenasserim R.
ELPHINSTONE IS.
ROSS ISLAND
MANGROVE SWAMPS
TIDAL AND FLATS
MERGUI ISLANDS
SELLORE IS
SCALE IN NAUTICAL MILES
5
0
5
10

VICINITY & APPROACHES


98°30'E.
IS.
ROCKS
N
LAND
To Tavoy Anchorage 80m.
To Rangoon 306m.
Sailing Line
Kyaukpya R.
Kalwin Pt.
Light
MERGUI
ND
Tenasserim R.
MANGROVE SWAMPS
TIDAL AND FLATS
MERGUI
ISLANDS
SELLORE IS



MANGROVE
SWAMPS
AND
TIDAL
MARSH
PATAW
ISLAND
Low water line
High water line
High water line
Low water line
Low water line
High water line
Sea wall
MERGUI
MANGROVE
SWAMP
INNER
ANCHORAGE
MAIN WHARF
PATIT
ISLAND
Naukle jetty
SWAMP
SCALE IN FEET
1000
500
0
1000
2000
3000

HARBOR AREA

MINISTRY OF NATIONAL PLANNING

OUTPORT OF MERGUI

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. H.R.N. E J F
CK. BY. H.R.N.
DATE. MAY 1953
PLATE NO. 18

2. PORT ADMINISTRATION

Like the other outports, the Port of Mergui is under the general supervision of the Nautical Adviser and Principal Officer, Mercantile Marine Department of the Ministry of Transport and Communications. However, as the port is operated on local funds, final decision on the utilization of these funds rests with the local District Commissioner. No port officer is assigned to Mergui.

3. WAR DAMAGE AND REHABILITATION

The principal war damage at the Port of Mergui included the destruction of dockside facilities, the damage of Naukle Jetty, the destruction and sinking of the pontoon jetty at the main wharf and of the crane on Naukle Jetty, and the destruction of all warehousing and customs facilities. In rehabilitating the port, the damaged structures along the waterfront and the sunken pontoon and crane were removed. The Naukle Jetty has been repaired temporarily, and, except for the wreck of a large Japanese freighter at the entrance to the Great Tenasserim River, the wrecks which would interfere with navigation have been removed.

In furtherance of rehabilitation and improvement of the Port of Mergui, the Mercantile Marine Department plans to strengthen and extend the Naukle Jetty about 50 ft. to reach greater depths of water. Through the assistance of the United States ECA/TCA program the materials have been received for a new 40 ft. by 250 ft. pontoon and as soon as the fabrication has been completed it will be installed at the main wharf to permit resumption of normal operations. The Mercantile Marine Department also intends to acquire a six-ton crane for installation on the Naukle Jetty and the construction of new warehousing and customs facilities as soon as funds become available.

4. ENTRANCE CHANNEL

As the light buoy off Kalwin Point is approached, the depth decreases rapidly until the critical depth of the waterway is reached near the light buoy. In general, the depths in the remaining three miles of the waterway are only slightly greater than the critical depth. Critical loading conditions will be governed by the following:

MLWS	*MLWN*	*MHWS*	*MHWN*
11·1 ft.	16·9 ft.	27·9 ft.	22·5 ft.

From the light buoy to Mergui the navigation course follows closely a series of depth pockets which average about 200 ft. in width at the two-fathom contour, MLWS datum. Fortunately these pockets are in regular alignment and the sailing course is in more-or-less two straight lines.

Because of the deep-water approaches to the Mergui channel and of the two straight courses of sailing, adequately marked by range beacons, no difficulty is encountered by small vessels in fair weather or daylight navigation on favorable conditions of tide. Pilot service is not used. Although the Mergui channel is in the delta of the Great Tenasserim River system, and thus is alluvial, the banks are relatively well defined and depth and width conditions of the navigable channel do not change materially from year to year. Depths and widths of channels are restrictive to seagoing commerce and even under the most favorable tidal conditions could not be used by the larger type of cargo vessel.

With the exception of the S.S. *Matang*, a vessel of 1,469 gross tons and a draft of 11 ft. belonging to the Straits Steamship Company and calling at Rangoon and the Tenasserim ports on a schedule of once every three weeks, the vessels calling at the Port of Mergui are the local seagoing schooners used in the coastal trade.

During the war both entrances to the Mergui channel, the two main sea approaches, and the general waters between Mergui and King Island, were mined extensively by both the Allied Forces and by the Japanese. Some sweeping has been accomplished in the north entrance to the Mergui channel and in the Great Tenasserim River entrance. While all of the remaining mines must still be considered as potentially active they should not interfere with the present type of shallow-draft vessels operating on the waterway; however, before any channel and harbor work can be carried out either for maintenance dredging or developing the port for larger vessels, it would be advisable to remove these hazards first in the sections to be worked. The wreck of the large Japanese freighter in the Great Tenasserim River near the south Mergui channel is an obstruction in the best anchorage area rather than a menace to navigation.

5. HARBOR AREA

The harbor area is considered that section of the channel fronting the city of Mergui, a distance of a little over one nautical mile. Most of the commerce is handled over the main wharf, the Naukle Jetty, and from the foreshore seawall. For distances of 200 to 500 ft. out from the shore there has been so much shoaling that the mud flats are exposed at lower tidal stages. Little use can be made of this area for commerce except by small craft, barges and sampans. During periods of high tide some of the cargo boats berth directly at the foreshore. The deep-water portion of the harbor and anchorage varies in width from 1,500 to 3,000 ft. and in depth from 18 to 60 ft. MLWS datum, thus providing a favorable basin both for anchorage and for lightering provided the number of seagoing vessels in port at one time does not exceed three or four. Tidal currents are strong in this area and during high flows of the Great Tenasserim River extreme ebb currents are present.

6. ANCHORAGES, WHARVES AND JETTIES

There are no mooring buoys at the Port of Mergui. The two public wharves are the main wharf and the Naukle Jetty. The main wharf is located at the south end of the revetment-protected foreshore. It consists of a steel-framed platform, supported on steel piles. The pontoon and bridge of the main wharf were destroyed during the war. A new pontoon 40 ft. by 250 ft., with an 80-ft. bridge, is being fabricated and its installation is scheduled during 1953. The main wharf is to serve mostly the passenger traffic. The Naukle Jetty is south of the main wharf and consists of a wide stone pier, at the end of which is a T-shaped steel-framed wharf of timber decking on steel piles. The length of the face of the jetty is 50 ft. The Naukle Jetty was damaged during the war and its reconstruction was completed early in 1953. During high-water periods the Naukle Jetty can accommodate up to four seagoing schooners; one at each side of the stone pier and two at the face of the jetty. During low-water periods the stone pier and part of the jetty are completely exposed. The jetty is of a light construction and vibrates under the slightest impact of moored schooners. Upstream from the main wharf there is one larger private timber pier, as well as some small barge and sampan landings, but they are not available for general-cargo handling.

7. TRANSIT SHEDS AND WAREHOUSES

A customs godown constructed of steel framing with corrugated sheet-metal roof and walls is located near the main wharf; it is old and in need of replacement. Two godowns are located at Naukle Jetty, one at each side of the stone pier. One godown is of brick construction and is for general cargo; the other is of steel framing and corrugated sheet-metal roof and walls and is Civil Supplies Godown No. 1. These godowns appear to be adequate for the present volume of cargo handling. A Civil Supplies Godown No. 2 of temporary bamboo construction is located at the waterfront, upstream from the main wharf.

8. CARGO-HANDLING EQUIPMENT

The only crane available for handling general cargo in the postwar period has been an old light caterpillar crane. The Mercantile Marine Department plans to install a six-ton crane at the Naukle Jetty at the earliest practicable date.

9. MARINE REPAIR

The only marine yards at the Port of Mergui are small local yards engaged in country-boat construction and repair. No facilities exist for major motor and steam launch and vessel repair; therefore, the Mercantile Marine Department is considering the installation of a small boatyard and shipway. The land and necessary materials have been acquired and the completion of the unit will be effected as soon as sufficient funds become available.

10. LABOR SUPPLY

All cargo handling at the Port of Mergui is accomplished by coolie labor. There is no apparent shortage of that type of labor in the Mergui area.

11. COMMERCE

While Mergui was one of the minor ports of Burma prior to the war, since the war, and particularly in the last two to three fiscal years, it has shown a marked increase in activity with commerce in fiscal year 1950-51 about twice the estimated high for the prewar period. The principal export commerce at Mergui includes rubber, tin and ngapi. Minor products include dried fish, dried prawns, rice, onions, chillies, tamarind, dholl and salt.

The following seagoing and coastwise commerce are the most recent recorded:

	1949–50 *(tons)*	*1950–51* *(tons)*
Exports	19,989	25,163
Imports	14,185	23,911
Total	34,174	49,074

12. CARGO HANDLING

With the exception of S.S. *Matang*, the vessels calling at the Port of Mergui are seagoing schooners berthing at Naukle Jetty, cargo boats and other small river craft. The cargo landed from or shipped in S.S. *Matang* is lightered to and from the shore. All cargo handling is by hand with coolie labor. Neither the local conditions nor the present volume of cargo justify a change of the present cargo-handling methods. However, because of the increase of rubber and tin production it appears that with the return of normal conditions the commerce of Mergui will increase considerably above the present levels in the next three to five years. At that time it would be prudent to investigate the possibilities of the improvement of cargo-handling methods such as increase of berthing space and wider use of wharf cranes.

13. CONCLUSIONS

The planning of the Mercantile Marine Department and the local port authorities and the district commissioner appears to be adequate for the needs of the harbor. Removal of wrecks and war-damaged structures has been completed; reconstruction of the main wharf and installation of the new 40-ft. by 250-ft. pontoon jetty will be completed in 1953; the Naukle Jetty is to be extended 50 ft. to deeper water and a six-ton crane installed thereon at the earliest practicable date; a new customs godown, warehouse and port offices structures will be built as soon as funds become available; the harbor and entrance channel are scheduled for dredging as soon as the first of two operating dredges becomes available; the installation of a small boatyard and shipway has been initiated for repair to harbour craft and others; and finally, after all other work has been completed it is planned to remove the wreck of the large freighter in the anchorage area of the Great Tenasserim River. When these improvements and rehabilitation measures have been completed there appears little else to accomplish to restore the Port of Mergui to a high operational efficiency.

14. ESTIMATED REQUIRED EXPENDITURES

The estimated expenditures for the Port of Mergui are as shown in the following tabulation. These costs have been separated into foreign costs and local costs; foreign costs represent the expenditures for equipment, supplies and materials not available locally; local costs are the expenditures for labor, materials and supplies available in Burma.

	Foreign Costs (K)	*Local Costs (K)*	*Total Costs (K)*
Service craft and pilot vessels	2,25,000	25,000	2,50,000
Maintenance equipment (prorated	4,50,000	50,000	5,00,000
Channel and port clearance	15,000	4,85,000	5,00,000
Navigation aids	90,000	10,000	1,00,000
Warehouses	6,00,000	4,00,000	10,00,000
Cranes	2,70,000	30,000	3,00,000
Dockyards	60,000	1,40,000	2,00,000
Total	17,10,000	11,40,000	28,50,000

It is recommended that the planned improvements and expenditures be carried out in the next five fiscal years at the rate of K10,50,000 the first year, K11,50,000 the second year, K3,50,000 the third year, and K1,50,000 for each of the following two years.

CHAPTER XIII

INLAND WATERWAYS

A. INTRODUCTION

1. IMPORTANCE AND EXTENT

The predominant role of the inland waterways in the national economy of Burma is due to the fact that the rivers and streams have been for centuries and still are the main ways of communication of the country. The great rivers traversing from north to south nearly the entire length of the country with their numerous tributaries offer over 5,000 miles of commercially navigable waterways; other thousands of miles are used by country craft which in many parts of Burma are the principal means of travel and transport. In the Irrawaddy delta, one of the great rice granaries of the world, the labyrinth of streams and creeks makes rail and road transport impracticable and water transport is the only means which is economical and convenient. Plate 1, entitled "Navigated Inland Waterways," shows the scheduled operations in service.

2. COMMERCE

Although records are not available of prewar cargo and passenger commerce on the inland waterways, the estimates indicate that the two principal prewar operators of riverine transport, the Irrawaddy Flotilla Company and the Arakan Flotilla Company, annually carried more than 8,200,000 passengers and more than 1,200,000 tons of cargo. However, in order to determine the total volume of riverine commerce, to the above figures should be added the volume of commerce carried by contract and private carriers, by country boats, and other craft. The resulting total may be as much as three or four times the amount shown above. Due to the loss of a large number of riverine craft during the war and particularly due to the later effects of the insurgency, the present volume of riverine commerce is less than 60% of the volume of the prewar period.

3. WAR DAMAGE AND REHABILITATION

Out of more than 600 craft of all types and sizes of the prewar fleet of the Irrawaddy Flotilla Company, only 105 could be salvaged and put in operation after the war. Other riverine fleets suffered similar damage. As an emergency measure several hundred vessels were placed at the disposal of the Inland Water Transport Board by the Military Transport Directorate; however, these vessels have been found unsuitable for commercial operations. Consequently, the Inland Water Transport Board initiated a three-year program and a ten-year program of rehabilitation of its fleet; similarly, a plan was prepared for the rehabilitation of the river conservancy fleet of the Mercantile Marine Department.

4. ORGANIZATION

The government agency responsible for the operation, regulation and control of inland water transport in Burma is the Inland Water Transport Board. It operates services on the Irrawaddy, the Chindwin and the Salween Rivers and their tributaries; the cargo services in the Arakan section (consisting mostly of moving paddy from the neighboring districts into the Port of Akyab and lighterage service in the Port of Akyab) are controlled by the Board through its agent, the Arakan Flotilla Company. This concern is a subsidiary of the British India Steam Navigation Company and operates its own passenger-steamer service also in the Arakan section independently of IWTB.

River conservancy, or the maintenance and marking of navigation channels of inland waterways, is under the jurisdiction of the Nautical Adviser and Principal Officer, Mercantile Marine Department.

B. EXISTING FACILITIES AND OPERATIONS

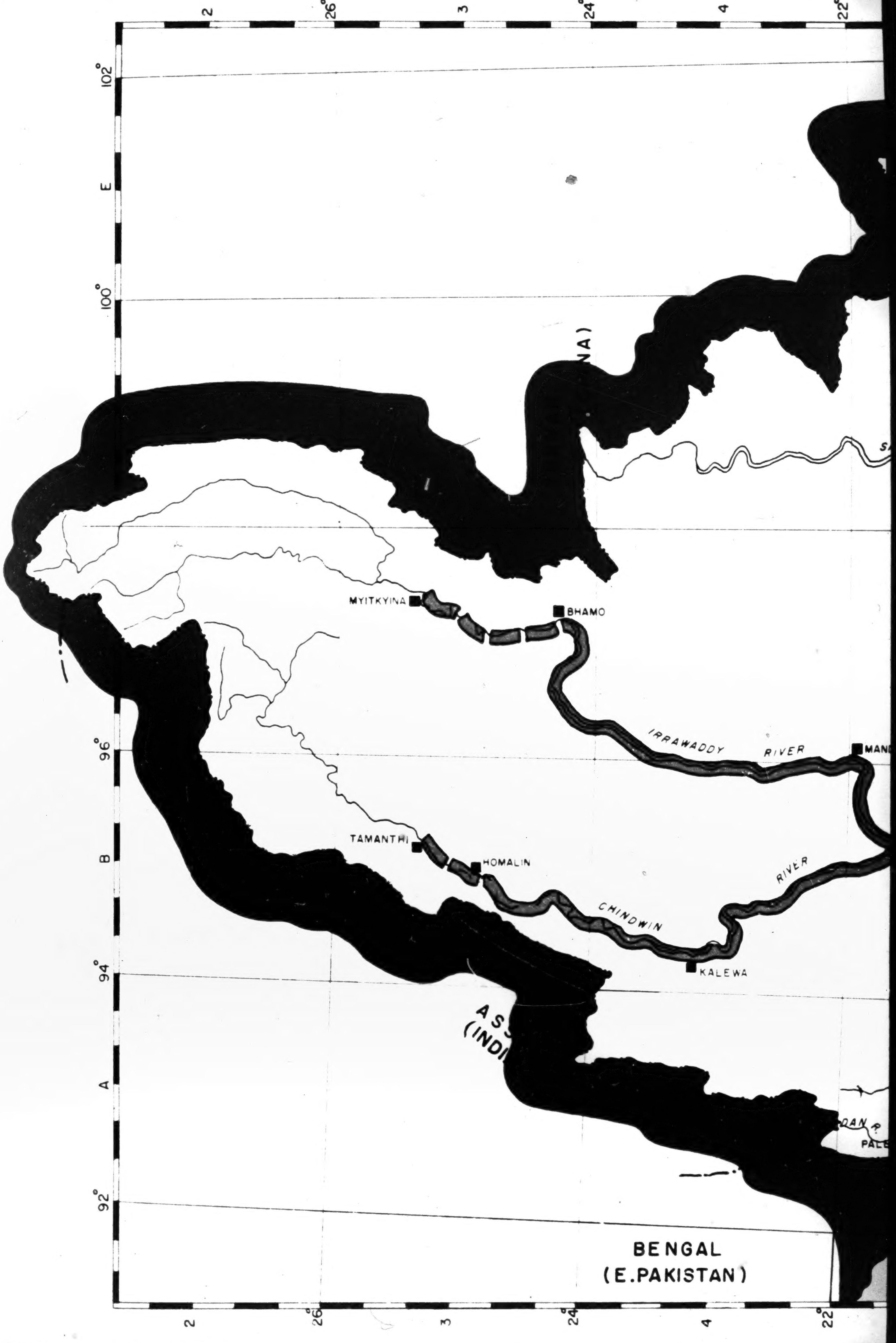
1. RIVER SYSTEMS OF BURMA

a. General Description

Burma consists of a series of river valleys running from north to south and separated by mountain ranges. The division of Burma by the water-heads of these rivers, expressed in per cent, is as follows:

	Per cent
Irrawaddy and Chindwin Rivers	55·03
Salween River and tributaries	18·42
Sittang River	5·37
Kaladan River and tributaries	3·75
Rangoon River and tributaries	2·95
Great Tenasserim River	2·69
Minor coastal streams	11·79
	100·00

The Irrawaddy and the Chindwin Rivers are the principal avenues of riverine commerce of Burma. Commercial transportation on the Irrawaddy can be



102°
E
100°
96°
B
94°
A
92°
26°
24°
22°
NA)
SA
MYITKYINA
BHAMO
IRRAWADDY RIVER
MAND
TAMANTHI
HOMALIN
CHINDWIN RIVER
KALEWA
ASS
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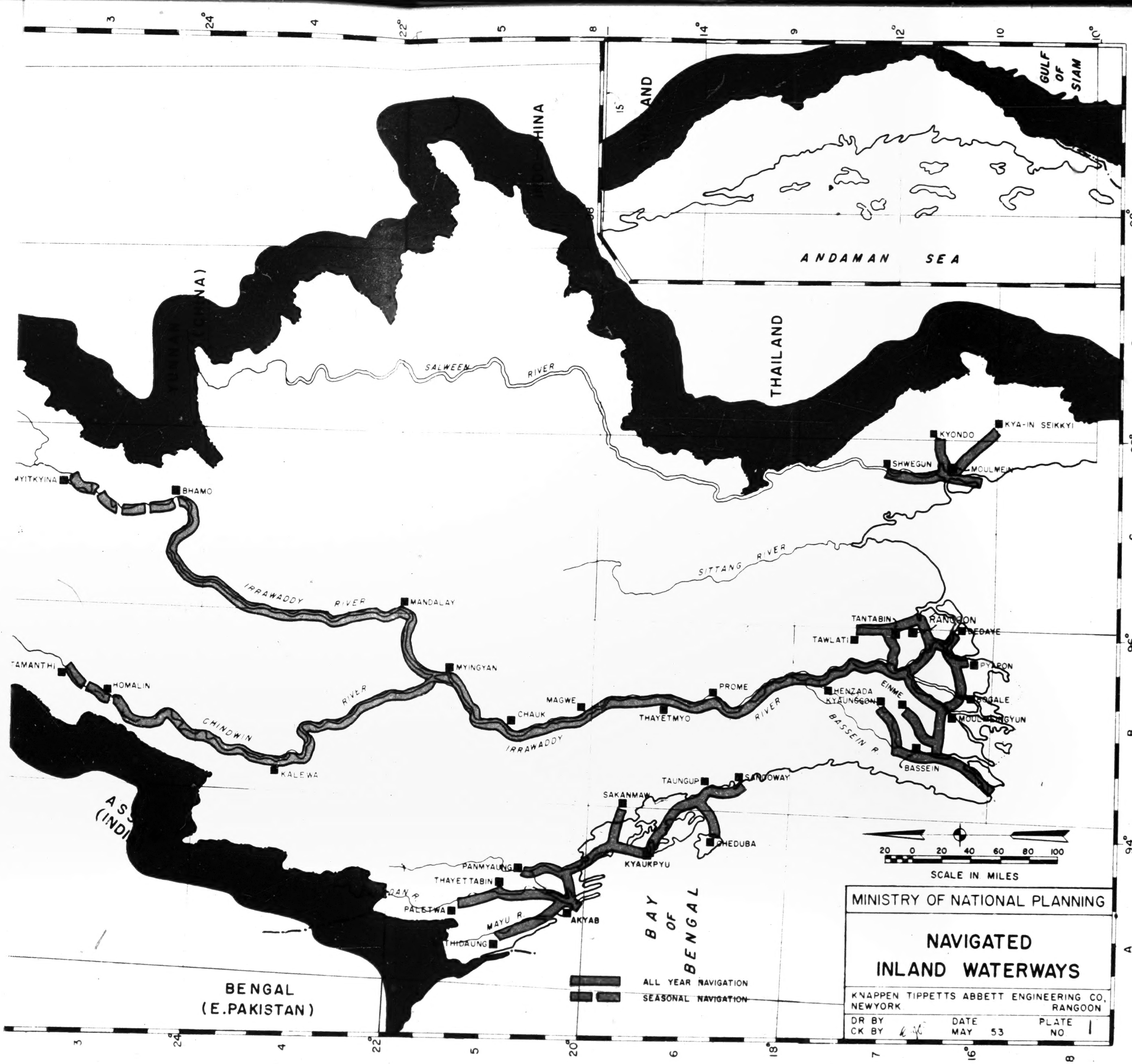
DAN R
PALE
BENGAL
(E.PAKISTAN)

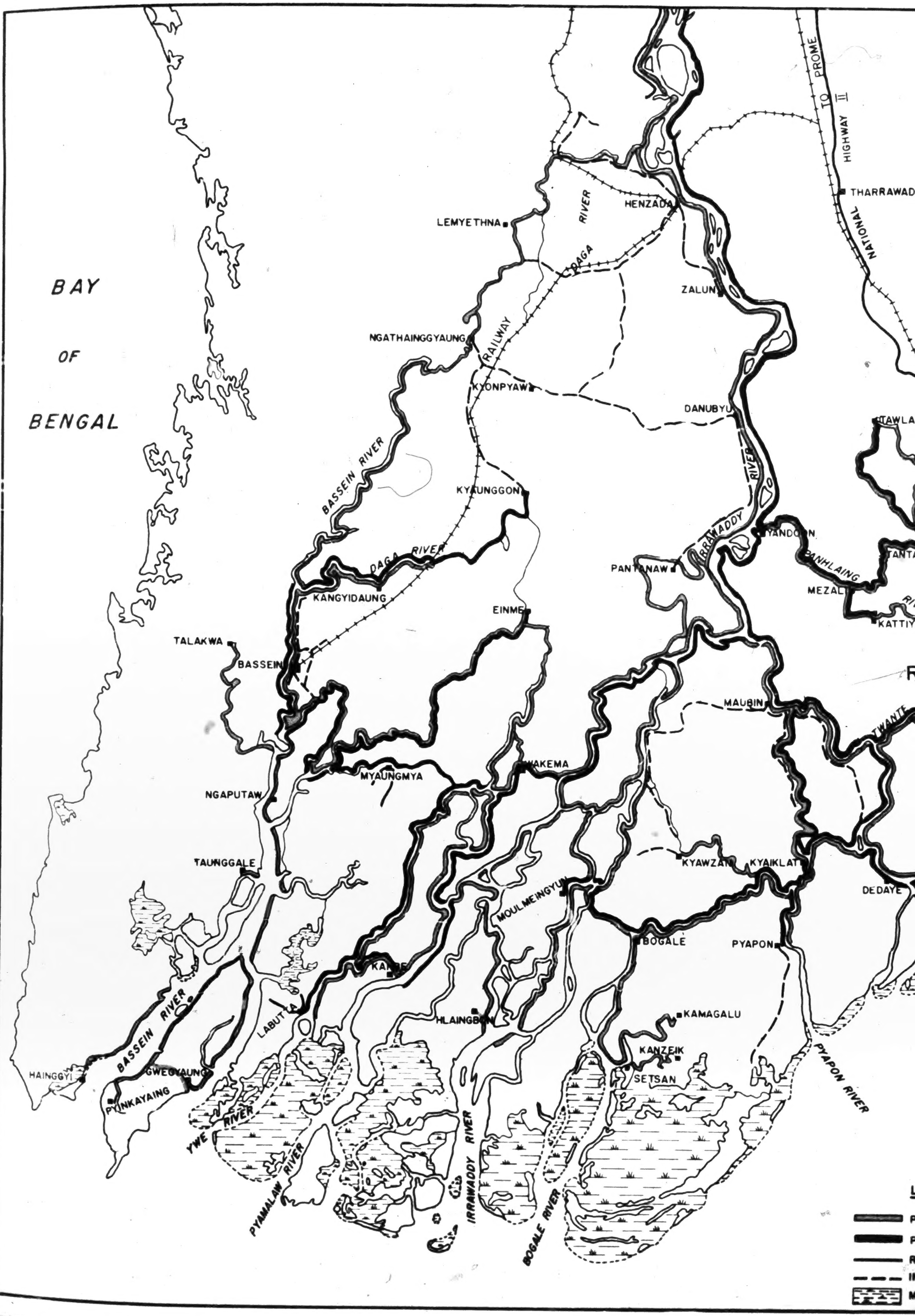

GULF OF SIAM
AND
15
CHINA
YUNNAN (CHINA)
ANDAMAN SEA
THAILAND
SALWEEN RIVER
SITTANG RIVER
KYONDO
KYA-IN SEIKKYI
SHWEGUN
MOULMEIN
MYITKYINA
BHAMO
IRRAWADDY RIVER
MANDALAY
MYINGYAN
TAMANTHI
HOMALIN
CHINDWIN RIVER
KALEWA
CHAUK
MAGWE
THAYETMYO
PROME
IRRAWADDY RIVER
TANTABIN
RANGOON
TAWLATI
DEDAYE
PYAPON
HENZADA
KYAUNGGON
EINME
BOGALE
MOULMEINGYUN
BASSEIN R.
BASSEIN
TAUNGUP
SANDOWAY
SAKANMAW
CHEDUBA
KYAUKPYU
PANMYAUNG
THAYETTABIN
KALADAN R.
PALETWA
MAYU R.
AKYAB
THIDAUNG
BAY OF BENGAL
ASSAM (INDIA)
BENGAL (E.PAKISTAN)
ALL YEAR NAVIGATION
SEASONAL NAVIGATION
20 0 20 40 60 80 100
SCALE IN MILES
24°
22°
20°
18°
16°
14°
12°
10°
94°
96°
98°
A
B
C
D

MINISTRY OF NATIONAL PLANNING

NAVIGATED INLAND WATERWAYS

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEWYORK RANGOON

DR BY	DATE	PLATE
CK BY	MAY 53	NO 1


BAY
OF
BENGAL
TO PROME
HIGHWAY II
NATIONAL
THARRAWAD
HENZADA
LEMYETHNA
RIVER
DAGA
RAILWAY
ZALUN
NGATHAINGGYAUNG
KYONPYAW
DANUBYU
TAWLA
BASSEIN RIVER
KYAUNGGON
IRRAWADDY RIVER
YANDOON
PANHLAING
TANTA
MEZAL
PANTANAW
DAGA RIVER
KANGYIDAUNG
EINME
KATTIY
TALAKWA
BASSEIN
R
MAUBIN
TWANTE
WAKEMA
MYAUNGMYA
NGAPUTAW
TAUNGGALE
KYAWZAN
KYAIKLAT
DEDAYE
MOULMEINGYUN
BOGALE
PYAPON
LABUTTA
HLAINGBON
KAMAGALU
KANZEIK
SETSAN
PYAPON RIVER
BASSEIN RIVER
HAINGGYI
GWEGYAUNG
PYINKAYAING
YWE RIVER
PYAMALAW RIVER
IRRAWADDY RIVER
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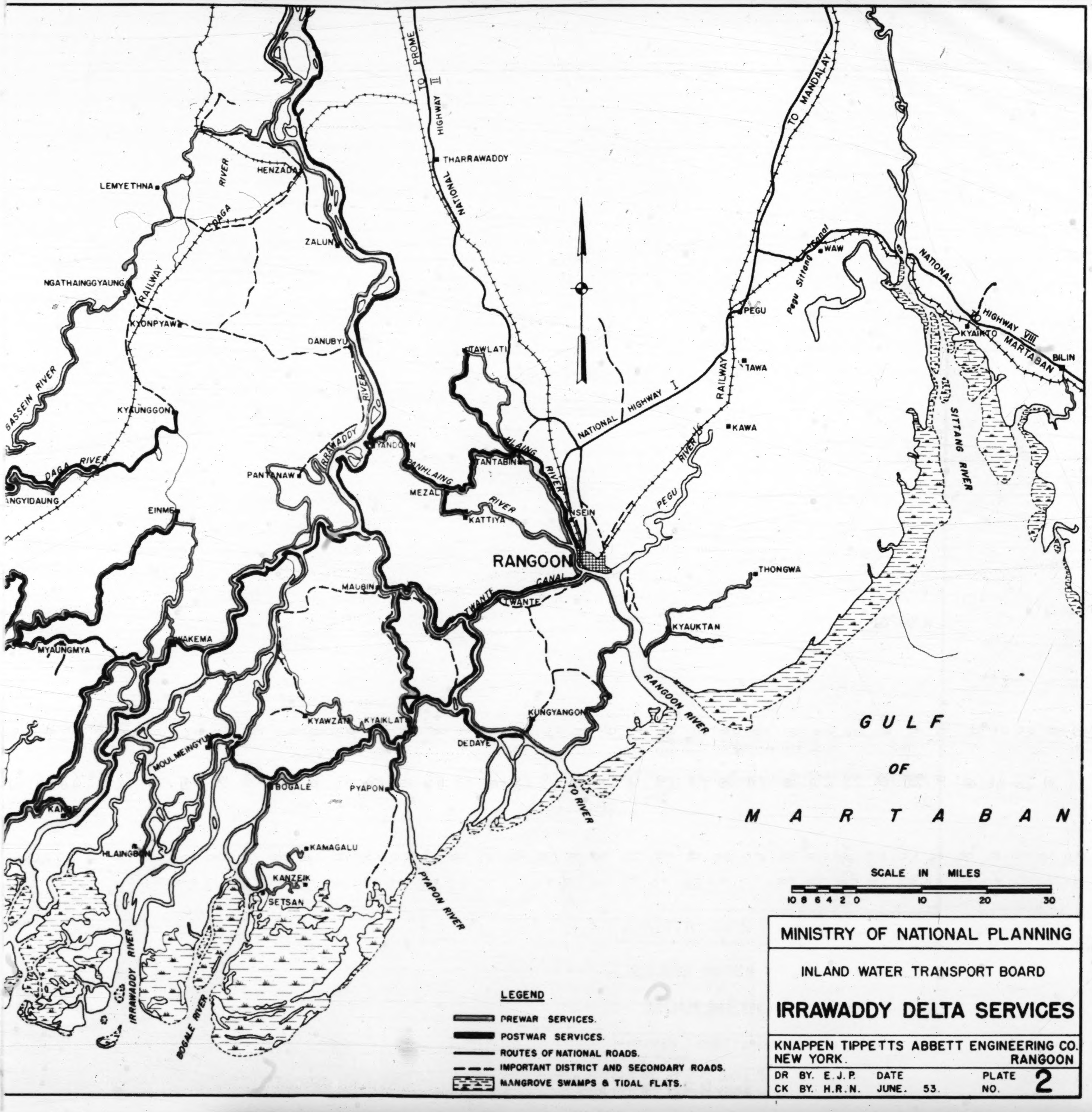
TO PROME
NATIONAL HIGHWAY II
TO MANDALAY
THARRAWADDY
LEMYETHNA
HENZADA
DAGA RIVER
RAILWAY
ZALUN
NGATHAINGGYAUNG
KYONPYAW
DANUBYU
BASSEIN RIVER
KYAUNGGON
DAGA RIVER
IRRAWADDY RIVER
YANDOON
PANTANAW
NGAYIDAUNG
EINME
PANHLAING RIVER
TANTABIN
MEZALI
KATTIYA
HLAING RIVER
TAWLATI
INSEIN
RANGOON
TWANTE CANAL
TWANTE
MAUBIN
NATIONAL HIGHWAY I
RAILWAY
PEGU
Pegu Sittang Canal
WAW
NATIONAL HIGHWAY VIII
KYAIKTO
TO MARTABAN
BILIN
TAWA
KAWA
PEGU RIVER
SITTANG RIVER
THONGWA
KYAUKTAN
RANGOON RIVER
WAKEMA
MYAUNGMYA
KYAWZAN
KYAIKLAT
KUNGYANGON
DEDAYE
MOULMEINGYUN
BOGALE
PYAPON
TO RIVER
KAKAYE
HLAINGBON
KAMAGALU
KANZEIK
SETSAN
PYAPON RIVER
IRRAWADDY RIVER
BOGALE RIVER
GULF OF MARTABAN
SCALE IN MILES
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LEGEND
PREWAR SERVICES.
POSTWAR SERVICES.
ROUTES OF NATIONAL ROADS.
IMPORTANT DISTRICT AND SECONDARY ROADS.
MANGROVE SWAMPS & TIDAL FLATS.

MINISTRY OF NATIONAL PLANNING

INLAND WATER TRANSPORT BOARD

IRRAWADDY DELTA SERVICES

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK. RANGOON

DR BY. E.J.P. DATE PLATE 2
CK BY. H.R.N. JUNE. 53. NO.

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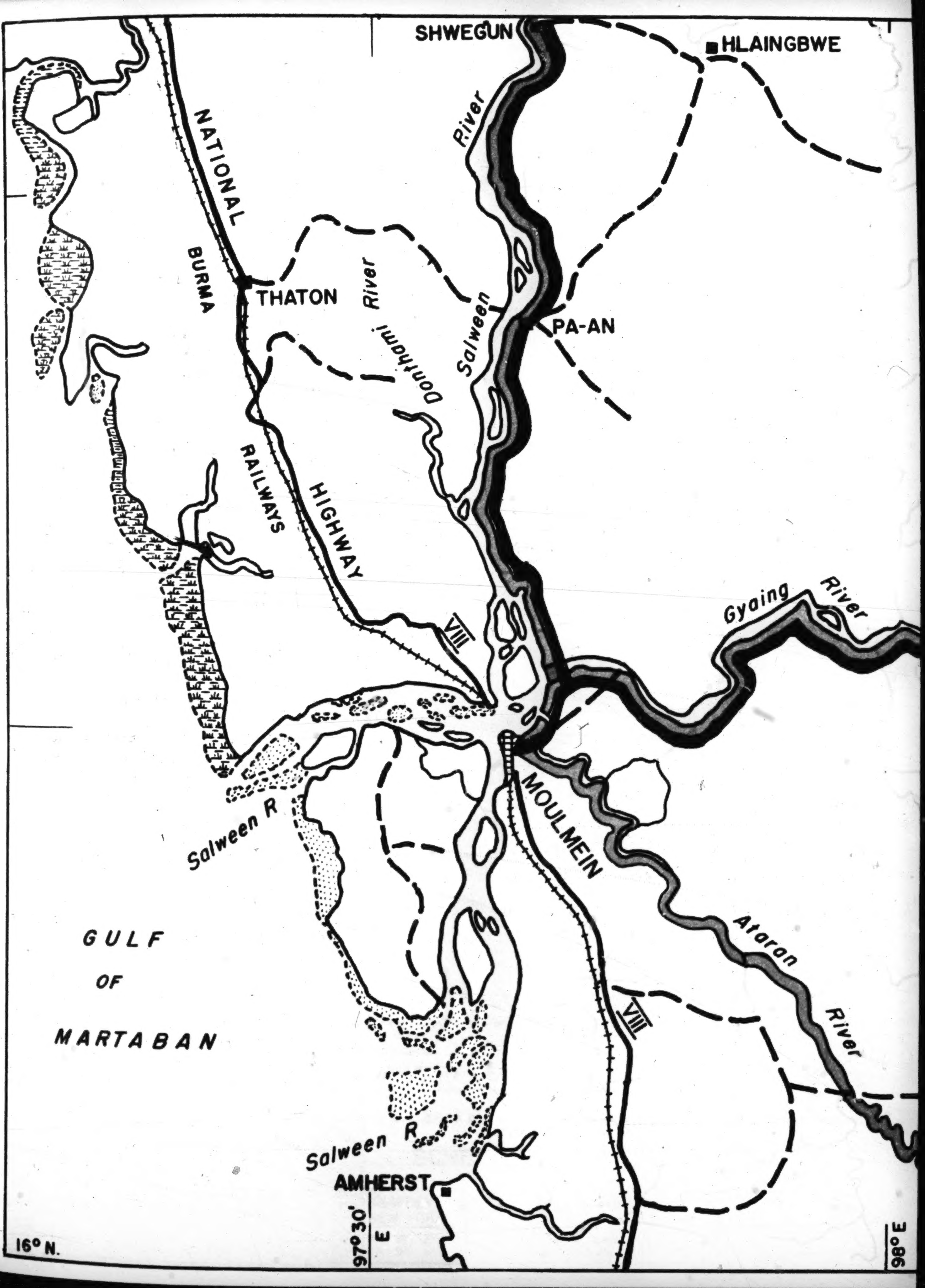
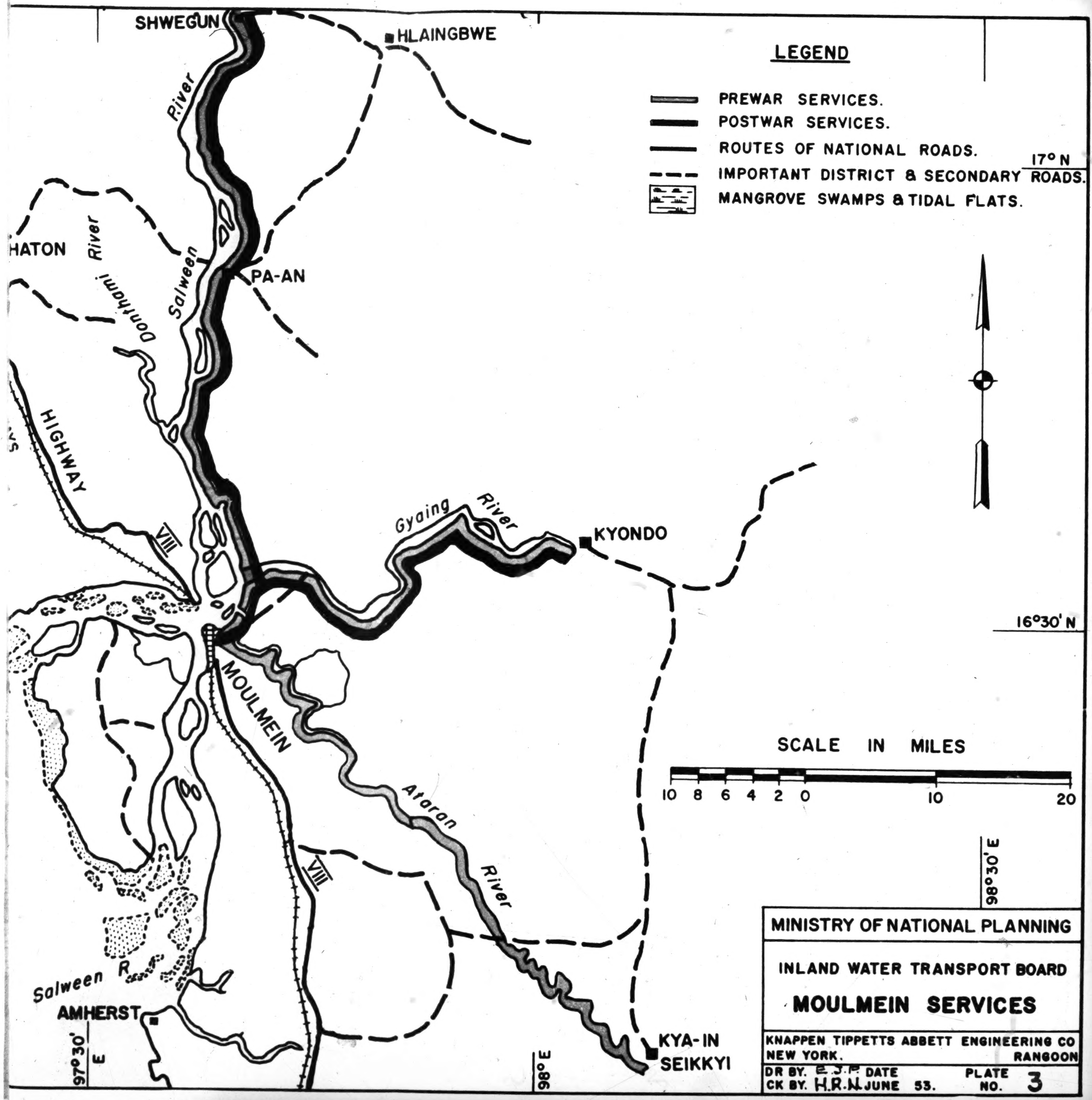

SHWEGUN
HLAINGBWE
NATIONAL
BURMA
RAILWAYS
THATON
Donthami River
Salween River
PA-AN
HIGHWAY
VIII
Gyaing River
MOULMEIN
Salween R
Ataran River
VIII
GULF OF MARTABAN
Salween R
AMHERST
16° N.
97° 30' E
98° E


SHWEGUN
HLAINGBWE
LEGEND
PREWAR SERVICES.
POSTWAR SERVICES.
ROUTES OF NATIONAL ROADS.
IMPORTANT DISTRICT & SECONDARY ROADS.
MANGROVE SWAMPS & TIDAL FLATS.
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HATON
River
Salween
Donthami
PA-AN
HIGHWAY
VIII
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River
KYONDO
16°30' N
MOULMEIN
SCALE IN MILES
10 8 6 4 2 0 10 20
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River
VIII
98°30' E
Salween R.
AMHERST
97°30' E
98° E
KYA-IN SEIKKYI

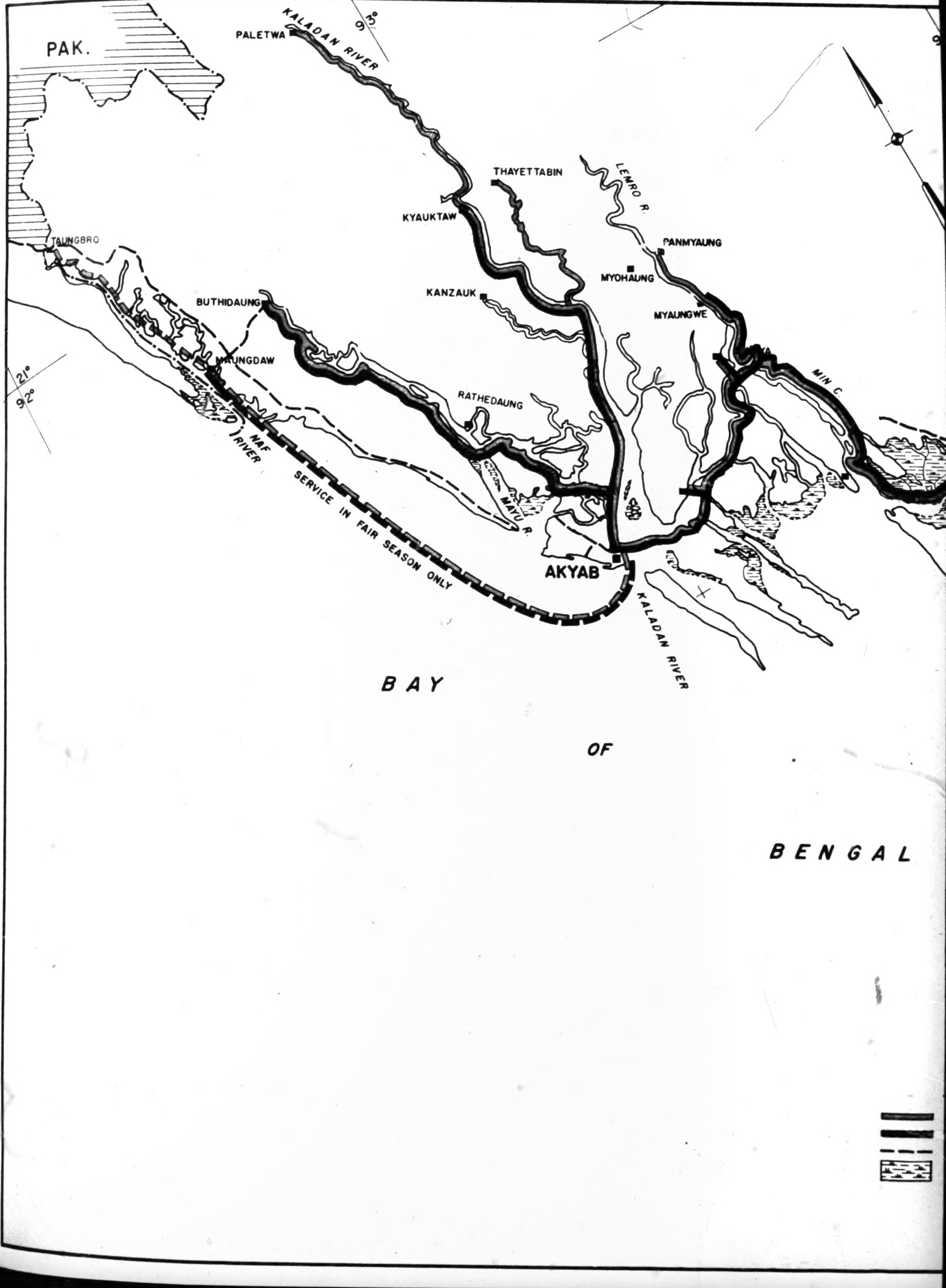
MINISTRY OF NATIONAL PLANNING

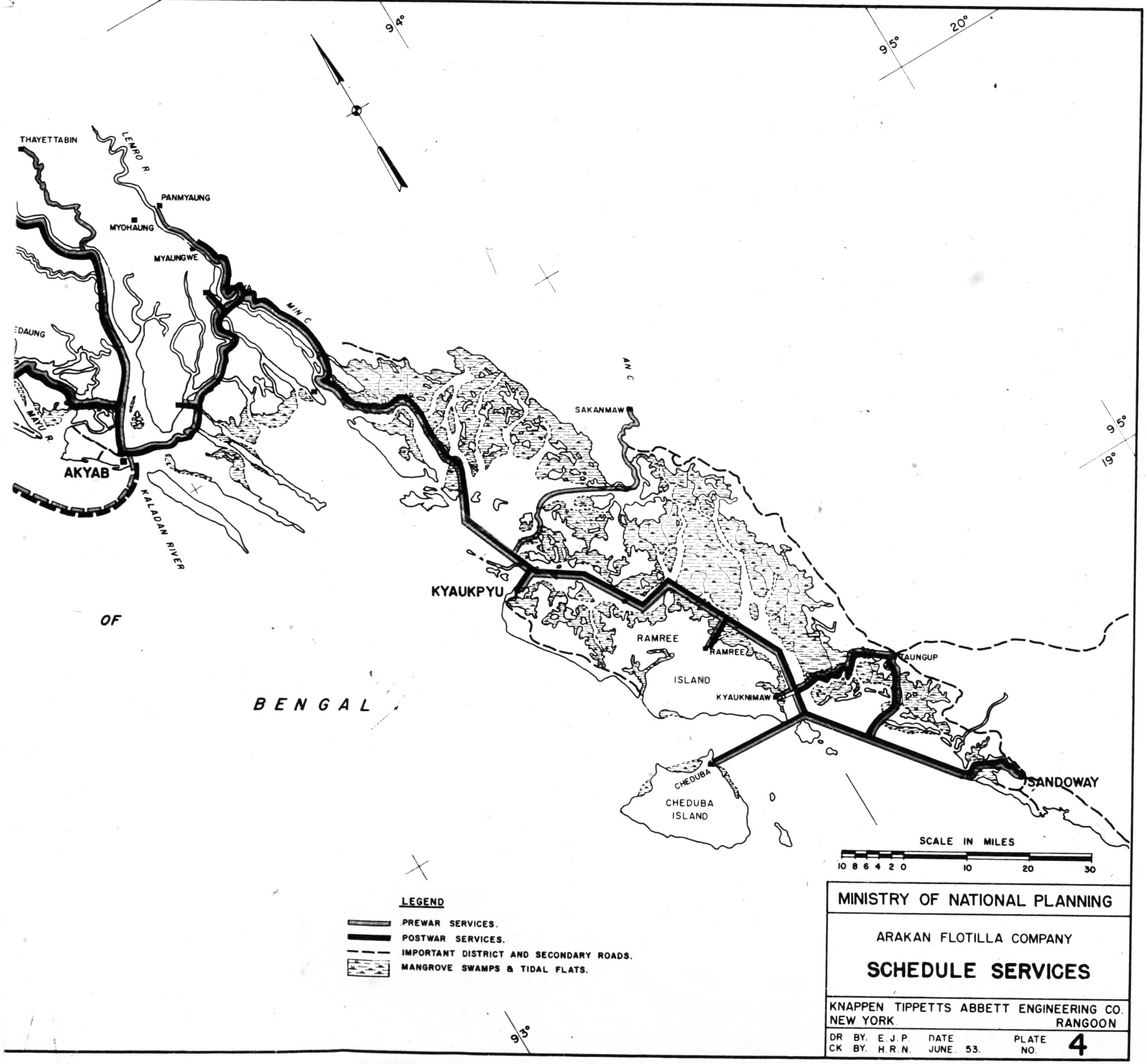
INLAND WATER TRANSPORT BOARD

MOULMEIN SERVICES

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK. RANGOON

DR BY. E.J.P. DATE
CK BY. H.R.N. JUNE 53.
PLATE NO. 3


PAK.
PALETWA
KALADAN RIVER
93°
THAYETTABIN
LEMRO R.
KYAUKTAW
PANMYAUNG
MYOHAUNG
KANZAUK
MYAUNGWE
TAUNGBRO
BUTHIDAUNG
MAUNGDAW
21°
92°
RATHEDAUNG
MIN C.
NAF RIVER
SERVICE IN FAIR SEASON ONLY
MAYU R.
AKYAB
KALADAN RIVER
BAY
OF
BENGAL


94°
95°
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19°
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THAYETTABIN
LEMRO R.
PANMYAUNG
MYOHAUNG
MYAUNGWE
MIN C.
EDAUNG
MAYU R.
AKYAB
KALADAN RIVER
OF
BENGAL
AN C.
SAKANMAW
KYAUKPYU
RAMREE
ISLAND
RAMREE
KYAUKNIMAW
TAUNGUP
SANDOWAY
CHEDUBA
CHEDUBA
ISLAND
SCALE IN MILES
10 8 6 4 2 0 10 20 30
LEGEND
PREWAR SERVICES.
POSTWAR SERVICES.
IMPORTANT DISTRICT AND SECONDARY ROADS.
MANGROVE SWAMPS & TIDAL FLATS.

MINISTRY OF NATIONAL PLANNING

ARAKAN FLOTILLA COMPANY

SCHEDULE SERVICES

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR BY. E. J. P. DATE PLATE
CK BY. H. R. N. JUNE. 53. NO. **4**

maintained for nearly 800 miles, 670 miles from Henzada to Bhamo throughout the year and 125 miles from Bhamo to Myitkyina for about seven months each year. To this mileage should be added about 2,000 miles of waterways in the Irrawaddy delta. The Chindwin River is open for commercial navigation from its mouth to Homalin, a distance of about 400 miles, throughout the year.

The Salween River is navigated commercially only for about 55 miles, from Moulmein to Shwegun. However, its main tributaries, the Donthami, the Gyaing and the Ataran Rivers add about 170 miles of navigable waterways in the Moulmein area.

The Sittang River is navigable for about 155 miles during the three months from mid-July to mid-October and for 25 miles throughout the year. This river lies within an area of high rice agricultural use.

The Kaladan, Lemro, Mayu and other rivers, with their tributaries, constitute the river system of the Arakan Coast, separated from the Irrawaddy by the Arakan Yomas. These rivers are navigable on tide for more than 400 miles.

The Rangoon River and its principal tributaries, Pazundaung Creek, Pegu River and others, while relatively small in drainage area and in the extent of navigable lengths carry probably the heaviest load of waterborne commerce in Burma because this river system comprises the approaches to the Port of Rangoon.

b. Effects of Rainfall

Rainfall occurs in Burma during the monsoon season from May to October, with its heaviest concentration in the months of June, July and August. The annual rainfall in the Arakan and Tenasserim regions often exceeds 200 inches and reaches 100 inches in the Rangoon area. Consequently, extreme variations occur between low water and flood stages of the rivers. A stage differential of 71 feet was experienced on the Kaladan River in 1929 and annual average variations of 31·7 ft. and 37·3 ft. have been recorded at Mandalay and Prome respectively. Except for the Chindwin, Irrawaddy and Salween Rivers, whose headwaters are in the high mountains of north Burma and Tibet, the base flows of the rivers of Burma are very low. Therefore, except during the periods of rain, commercial navigation on these rivers is possible only to the head of tidewater.

c. Tidal Effects

All the main rivers of Burma flow to the sea, so their lower reaches and deltas are subject to tidal effects. The difference between Mean Low Water Springs and Mean High Water Springs tides vary approximately as follows:

Mouth of Kaladan River (Akyab)	7·3 ft.
Mouth of Bassein River (Diamond Island)	6·3 ft.
Mouth of Rangoon River (Elephant Point)	18·0 ft.
Mouth of Salween River (Amherst)	19·0 ft.
Mouth of Tavoy River (Reef Island)	15·5 ft.
Mouth of Great Tenasserim (Mergui)	16·8 ft.

It can be seen that in the tidal influence many of the water courses can be navigated on favorable tide conditions. Of the estimated 5,000 miles of inland waters of Burma which are and have been used commercially, over 4,000 miles lie within the tidal influence.

2. NAVIGATING CONDITIONS

On those rivers which have a sufficient base flow to support navigation either throughout the entire year or a part thereof, as the Irrawaddy and Chindwin Rivers, the navigating conditions are controlled by critical depths and widths; on rivers and deltas along the coast the navigation is basically limited to the tidal sections.

On the Irrawaddy River the lowest levels are usually reached in February and March and the drafts of vessels are at present limited to the following:

Rangoon to Prome	5 ft.
Prome to Yenangyaung	4 ft. 9 ins. to 5 ft.
Yenangyaung to Mandalay	4 ft. 3 ins. to 4 ft. 9 ins.
Mandalay to Bhamo	3 ft. 6 ins. to 4 ft.
Bhamo to Myitkyina	2 ft. 6 ins. to 3 ft.

In general, from December to March the river is from 0 to 5 ft. above the lowest level, and from mid-June to mid-October the river is from 20 to 30 ft. above the lowest level and it is usually necessary to have separate high- and low-water landing points at the riverine ports.

The useful width of the river is controlled by the sharpness of the bends which limit the length of vessels or the over-all dimensions of a tow which can ascend or descend the river. Between Rangoon and Mandalay the permissible over-all dimensions for a tow of 4 to 4·5 ft. of draft during the low-water season are:

Width—Good conditions —200 ft.
Normal conditions —150 ft.
At bad shoal crossings—100 ft. with difficulty.
Length—Up to 450 ft. in normal or fairly adverse conditions.

Between Mandalay and Bhamo the over-all dimensions of a tow of 3·5 to 4-ft. draft during low-water periods are approximately:

Width—Normal conditions —110 ft.
At bad shoal crossings—70 ft. with difficulty.
Length—Up to 400 ft. normal or adverse conditions.

Between Bhamo and Myitkyina the length and width of the operating craft are limited by the sharp and narrow bends between rocks in the first defile and probably the maximum of 150 ft. by 50 ft. can be set for this section.

The Chindwin River is considered navigable by steam vessels as far as Homalin, about 400 miles upstream of the mouth; however, launches can reach Tamanthi (57 miles above Homalin) in the rains and small launches can go as far upstream as Singkaling Hkamti (123 miles above Homalin) through the year. Homalin usually is considered as the head of navigation and the maximum draft up to Homalin during low-water is 2·5 to 3 ft. At Homalin the river is about 500 yards wide.

The Salween River, although one of the largest rivers of the world, except for its lower reach near the mouth, is unfit for general navigation due to numerous rapids and cascades. Launches of about 110 ft. in length can reach Shwegun about 55 miles upstream from Moulmein, but in dry weather a trans-shipment is usually necessary at a bar 12 miles below Shwegun. In dry weather motor boats and country boats can reach Meseik, 28 miles above Shwegun.

The Sittang River in its lower reaches, below the Pegu–Sittang Canal, is dangerous to navigation due to numerous sandbanks in the delta and to a tidal bore which occurs daily between September and May. Above the Pegu–Sittang Canal, the Sittang is navigable by launches of about 50 ft. by 15 ft. and 4·5 ft. draft for 25 miles (to Madauk) throughout the year and for an additional 130 miles (to Toungoo) during the rains from mid-July to mid-October.

In the Kaladan River the tidal effects are felt as far upstream as Paletwa, a distance of about 98 miles from the Bay of Bengal. The Kaladan is a formidable river in the rains with a normal flood level of nearly 45 ft. above the normal dry-weather stage. The least depth at ordinary low-water is about six ft. and the least channel width is from about one half mile at Paletwa to over five miles at the Port of Akyab. On the various tributaries of the Kaladan River and other streams in the Kaladan area, the least depth varies from two ft. to five ft. and the least width of channel from 50 to 300 ft.

The navigating conditions on the Rangoon River, Pazundaung Creek and Pegu River were described in section B–5 of Chapter XII.

The Great Tenasserim River is navigable for launches and motor boats throughout the year for about 45 miles above Mergui, to the town of Tenasserim. The boats, mostly built locally, are about 50 to 60 ft. long and 20 ft. wide. In the monsoon season these boats can go an additional 20 miles above Tenasserim, to Tagu.

3. RIVERINE CRAFT TYPES

The development of the original type of vessels used on the rivers of Burma was controlled by the critical depths and widths of the streams, intensity of currents and other hydraulic factors, in addition to the requirements of commerce. On the Irrawaddy River in the Mandalay trade the vessel was of a large cargo-passenger-steamer type, usually equipped with stern or side paddle wheels. These vessels varied in size up to 310 and 326 ft. in length, 46 ft. (plus 30 ft. for paddle boxes) in width. The vessels operated either alone or with two barges in tow, one at each side of the vessel. The barges were usually 250 ft. by 34 ft.

From Mandalay to Bhamo smaller steamers of the same type were used, about 235 ft. in length and 30 ft. (plus 20 ft. for paddle boxes) in width. From Bhamo to Myitkyina and on the Chindwin River to Homalin similar vessels were used; upstream from Bhamo the river limits the vessel size to about 150 ft. by 50 ft.

The Arakan Flotilla Company operates double- and single-decked passenger steamers with a cargo-carrying capacity of only about 40 tons per ship. The steamers used in services to Kyaukpyu and Sandoway have deep drafts. Besides its own vessels the Arakan Flotilla Company operates government-owned tugs and barges for cargo service.

Large steamers are not adaptable in the tidal sections of Burma's rivers with their shallow sinuous watercourses. Furthermore, much of the cargo is carried to the ports by country craft and barges and the basic demand was for rapid transport of miscellaneous cargo and passengers. The resulting vessel was a fast twin-screw launch usually of double-decked type.

C. OPERATION OF INLAND WATER TRANSPORT

1. INLAND WATER TRANSPORT BOARD

a. Organization

The Inland Water Transport Board was constituted in 1946. It consists of 14 members and controls and operates three sections: the Irrawaddy Section, the Lighterage Section, and the Arakan Section. The Irrawaddy Section of IWTB took over the organization of the former Irrawaddy Flotilla Company when the latter was nationalized in 1948. It operates the services on the Irrawaddy and Chindwin Rivers and in the Moulmein District. The Arakan Section operates the government-owned cargo fleet in the Arakan area through its agent, the Arakan Flotilla Company; the Lighterage Section in the Port of Rangoon operates a lighterage fleet of about 10,000 tons capacity which is used for 30 to 40% of all lighterage work in that port.

b. Prewar and Postwar Sailing Routes

The prewar routes of the Irrawaddy Section of IWTB are shown on Plates numbered 2 and 3, and respectively entitled "Irrawaddy Delta Service," and "Moulmein Services." On the Irrawaddy River services are maintained at present to Bhamo; on the Chindwin River services extend to Mawlaik and in the rainy season up to Tamanthi. In the Irrawaddy Delta about one third of prewar services is maintained. The trade routes of the Arakan Flotilla Company are shown on Plate 4, entitled "Schedule Services."

The over-all reduction of services is due mostly to insurgent activity. Only part of the IWTB fleet now is in operation, traveling only during the daylight hours and under military escort. The extent of the reduction of traffic is indicated by the data presented in paragraph d.

c. Main River Ports on Irrawaddy and Chindwin Rivers

The principal riverine stations on the Irrawaddy River and their distances from Rangoon measured in river miles via the Twante Canal, are as follows:

Yandoon	— 76	miles	Chauk	—410	miles
Henzada	—131	,,	Myingyan	—472	,,
Prome	—235	,,	Mandalay	—552	,,
Thayetmyo	—276	,,	Katha	—725	,,
Magwe	—346	,,	Bhamo	—802	,,
Minbu	—349	,,	Myitkyina	—927	,,
Yenangyaung	—357	,,			

Only a few of these localities have landing facilities, consisting mostly of one or two flats or barges. In most cases the vessels moor alongside the river bank. There are generally two different landing stages, one is used during the high-water period and another during the dry season. They are often separated by a considerable distance and in many cases no proper road exists between the landing stage and the town. Cargo storage facilities are generally not available and cargo is stored either on the landing flats and barges (some of which are roofed) or openly on the river banks. The more important of these river ports are:

Henzada, which is considered as the beginning of the Irrawaddy delta and which is the junction of the railways to Kyangin and Bassein. The Prome to Rangoon railway line has a connection to Tharrawaw and ferry connection between Tharrawaw and Henzada.

Prome, which is the head of rail and highway from Rangoon.

Chauk, which is in the heart of the oil fields. The Burmah Oil Company has facilities here for handling petroleum shipments in bulk and in barrels.

Mandalay, which is the main city of upper Burma and the rail and highway center of northern Burma.

The principal localities served by the steamers on the Chindwin River and their distances from the mouth of the Chindwin are as follows:

	River miles		*River miles*
Monywa	54	Paungbyin	317
Kalewa	195	Homalin	381
Mawlaik	239	Tamanthi	438
Sittaung	295		

As there is no railway in Chindwin valley north of Monywa and essentially no highways, riverine craft are the main means of communications of the hinterland of the Chindwin River. The landing stages at the localities listed above are even more primitive than those at the Irrawaddy. Kalewa may attain a prominent position among the Chindwin ports should the coal deposits there be developed; entirely new landing and cargo-handling facilities would have to be provided. Should the planned industrial development in the Myingyan area be realized, this new river port would require adequate provisions for cargo handling.

d. Commerce, Prewar and Present

The annual average of prewar commerce was indicated as over 1,200,000 tons cargo and more than 8,200,000 passengers. For the last two fiscal years the commerce carried by IWTB was as follows:

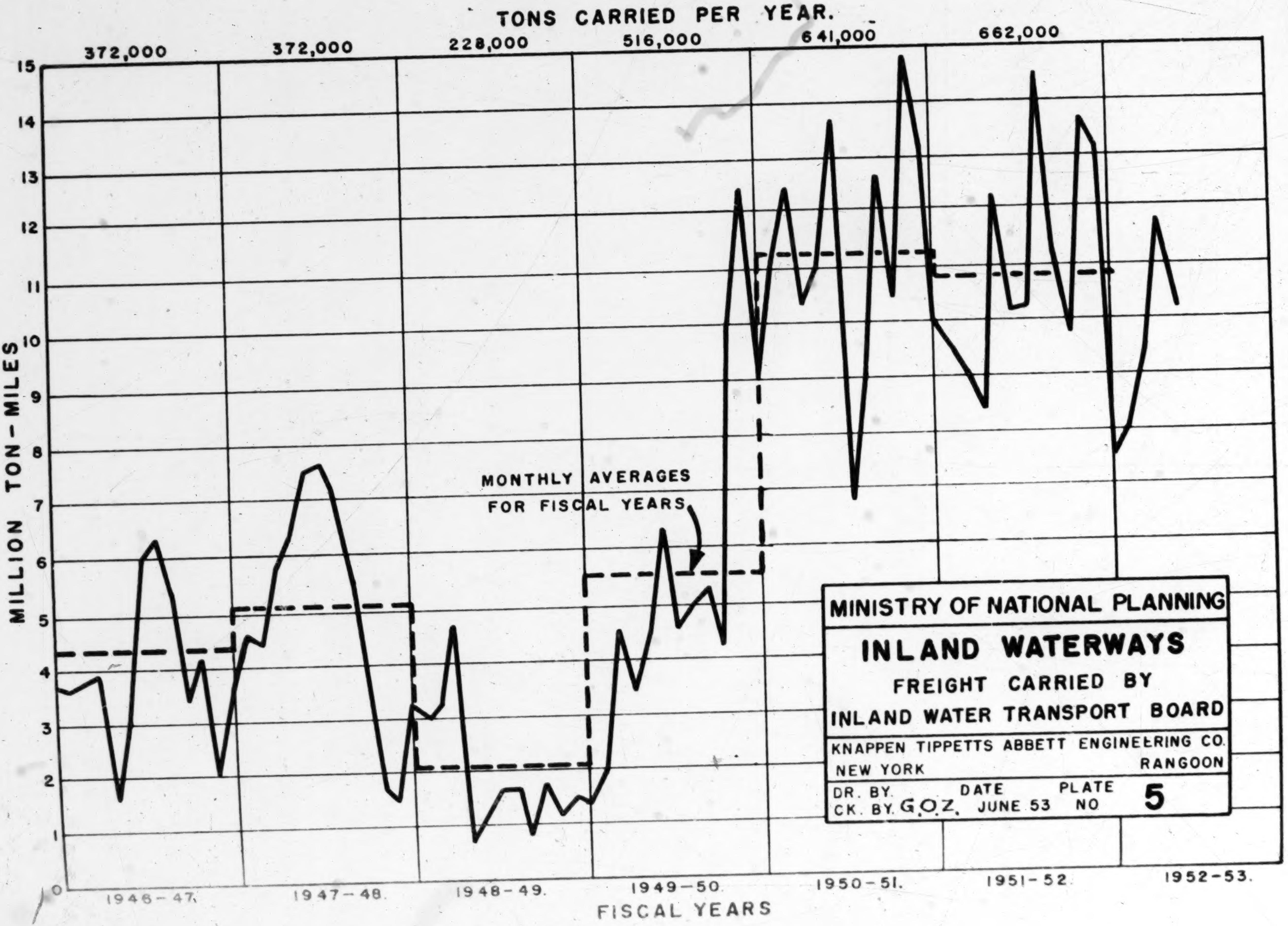
	1950–51	*1951–52*
Cargo, tons	641,000	662,000
Passengers	2,530,000	3,080,000

Compared with the estimated prewar commerce, the above figures indicated a reduction of about 45% of cargo trade and of about 62% of passenger trade. As mentioned previously, this reduction is due mainly to conditions of insurgency although noticeable recovery took place in the last few years. The influence of insurgency on the volume of freight carried by IWTB in the postwar period is illustrated by Plate 5, entitled "Freight Carried by Inland Water Transport Board." The principal goods transported by the vessels of IWTB are rice and local consumable commodities.

e. Flotilla

(1) Prewar Status

Prior to the war the fleet of the Irrawaddy Flotilla Company consisted of 246 powered craft of all types and of 372 various barges, or a total of 636 vessels of all description. This fleet was essentially destroyed during the war.



MINISTRY OF NATIONAL PLANNING

INLAND WATERWAYS

FREIGHT CARRIED BY

INLAND WATER TRANSPORT BOARD

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.

NEW YORK RANGOON

DR. BY. DATE PLATE

CK. BY. G.O.Z. JUNE 53 NO 5

(2) Postwar Status and Rehabilitation Program

By 1950 the fleet of IWTB numbered about 556 vessels; however, out of this number only about 19 powered craft and 86 barges were salvaged and reconditioned prewar vessels. The balance consisted of 84 powered vessels and 50 barges of new construction and of some 300 craft of the Military Directorate of Transport. The total gross tonnage of the powered craft amounted to only 22,000 tons as against approximately 49,000 gross tons of the prewar fleet. The corresponding figures for barges were 40,000 tons and 191,000 tons.

In order to replace the military craft which were too expensive in commercial operations and to rebuild the fleet to approximately its prewar strength, IWTB adopted a three-year program of acquisition of new vessels, estimated to cost about K2,00,00,000. This three-year program is the initial stage of a ten-year program of a complete fleet rehabilitation estimated to cost about K15,00,00,000.

The prewar Irrawaddy Flotilla Company introduced diesel-powered craft as early as 1930. A transition from steam to diesel power is being carried out in the present craft which are in good condition; and diesel power is being used mostly for the new fleet. Most of the steam-powered paddlers were changed to oil firing.

The IWTB are considering whether to continue their new ship-building program along the lines of the prewar fleet or whether to introduce a pusher type of towboat similar to those used in the United States and South America. However, it should be pointed out that the degree of efficiency of a push towboat on the Irrawaddy River would depend not only on the manner of its operation but also on the physical characteristics of the stream. The width and depth of the channels, and particularly the degree of curvature of the bends, would be the critical factors in determining the size and length of push-towboat and barge units. Before IWTB invests too heavily in replacing their towboats, experiments should be made with trial tows using the available plant and converted equipment to determine whether push towing of large enough units can be used on the rivers.

2. ARAKAN FLOTILLA COMPANY

a. Organization

At present the Arakan Flotilla Company operates the cargo services in the Arakan area as an agent of IWTB and the passenger service as a separate venture. However, if Government acquires the Arakan Flotilla Company from the British India Steam Navigation Company all riverine services could be incorporated in the Arakan Section of IWTB.

b. Prewar and Postwar Sailing Routes

The prewar and postwar routes of the Arakan Flotilla Company are shown on Plate 1. The discontinuance of several services, due to the insurgency and to the destruction of the fleet during the war, reduced the total length of sailing routes by about 50% from approximately 1,700 miles prewar to less than 900 miles at present. Indicative of the reduction of services is also the number of weekly sailings; before the war there were 22 weekly sailings from Akyab; in 1953 there were only about eight to nine.

c. Commerce, Prewar and Present

The estimated prewar commerce carried by the Arakan Flotilla Company amounted to 60,000 tons of cargo and 225,000 passengers. In the last two fiscal years the following commerce was reported:

	1950–51	*1951–52*
Cargo, tons	29,800	35,133
Passengers	140,400	Not available

Compared with the estimated volume of prewar commerce these figures indicate a reduction of about 41% in cargo trade and of about 37% in passenger trade.

The principal domestic imports carried by the Arakan Flotilla Company consist of paddy and of small quantities of country produce. The principal exports are the consumer goods for riverine stations.

d. Flotilla

Before the war the Arakan Flotilla Company had in operation 13 double-deck passenger launches (for 275 to 300 passengers each) and two single-deck passenger launches (for 150 to 175 passengers each). These vessels were destroyed or damaged during the war and the present fleet consists of three double-decked passenger launches which were salvaged and reconditioned, three newly built launches of the same type, and one single-decked passenger launch. These craft are operated on the company's own account. Furthermore, the Arakan Flotilla operates as an agent of IWTB some 20 barges, of a total capacity of about 3,200 tons, and six to eight tugs. This cargo fleet is government-owned and is used primarily for transportation of paddy from the districts into Akyab and for lighterage service in the Port of Akyab.

3. PRIVATE OPERATORS OF INLAND WATER TRANSPORT

According to available data there are at least 180 privately owned riverine craft operating on the Irrawaddy River and delta and in the Moulmein section in competition with IWTB. The number of these private vessels represents more than 30% of the number of IWTB craft. These private vessels are mostly motor launches with a maximum capacity of only 120 tons. More than 70% of them operate in the Irrawaddy delta. The owners of these craft are organized in an association called "The Burma Inland Water Transport Union Headquarters." According to IWTB, most of these craft are not properly maintained and are of doubtful seaworthiness and numerous accidents have occurred with serious loss of life and property.

4. SHOP REPAIR FACILITIES

IWTB operates its Dockyard at Dalla, across the Rangoon River from the City, and its unit at the Rangoon Foundry in Rangoon. These facilities have been described in detail in paragraph B–10–a of Chapter XII. IWTB also maintains marine repair yards at the seaport of Moulmein and at the riverine port of Mandalay. The Arakan Flotilla Company maintains slipways and repair facilities at the Port of Akyab. In the consideration of providing economic national marine facilities and of minimizing duplicity of working units, the recommendation was made in paragraph B–16–g–(4) of Chapter XII to consolidate all marine repair and docking facilities under a new government organization, a Department of Yards and Docks.

D. NEW INDUSTRY REQUIREMENTS

1. TRANSPORT OF COAL FROM KALEWA

a. General

Associated economic studies estimated that by fiscal year 1959–60 the annual coal requirements of Burma would amount to about 580,000 tons provided the planned industrial program is realized. It is considered that these requirements could be supplied by the output of Kalewa Coal Mines, estimated at 400,000 tons per year, and by the foreign import from India of the remaining 180,000 tons. A separate project report entitled "The Transport of Kalewa Coal" presents the comparative analyses of possible means of transport of coal from Kalewa to various centers of distribution, the types and cost of the required riverine fleets, the cost of necessary river-conservancy operations, and the comparative rates of transport by rail and water of Kalewa coal and of imported coal. A brief summary of findings and conclusions of this project report is presented in the following discussion.

b. Coal Requirements

It was estimated that the requirements for washed and processed coal at various distribution centers would be as shown in the following tabulation:

	Washed Coal (long tons)	*Processed Coal (long tons)*	*Totals (long tons)*
NORTHERN SECTOR			
At Kalewa			
Generation electric power	28,000		
Subtotal	28,000		28,000
At Myingyan Industrial Site			
Generation electric power	50,000		
Industries	75,000		
Waterways transport		7,000	
Zinc Refinery		16,000	
Subtotal	125,000	23,000	148,000
At Mandalay			
Burma Railways	20,000	45,000	
Namtu Smelters		15,000	
Subtotal	20,000	60,000	80,000
Total Requirements of Northern Sector	173,000	83,000	256,000
SOUTHERN SECTOR			
At Rangoon			
Burma Railways	20,000	65,000	
Waterways transport		13,000	
Generation electric power	38,000		
Rangoon Corporation		8,000	
Present industries		15,000	
New industries	135,000		
Antimony Project		20,000	
Commissioners for the port		5,000	
Private boat owners		5,000	
Total Requirements of Southern Sector	193,000	131,000	324,000
Total Coal Fuel Requirements of Burma	366,000	214,000	580,000
Output of Kalewa	234,000	166,000	400,000
Import from India			180,000

c. Analysis of Various Methods of Coal Transport

Three different methods are possible for supplying the coal to the distribution centers listed in the preceding paragraphs. They are:

(1) Riverine Transport

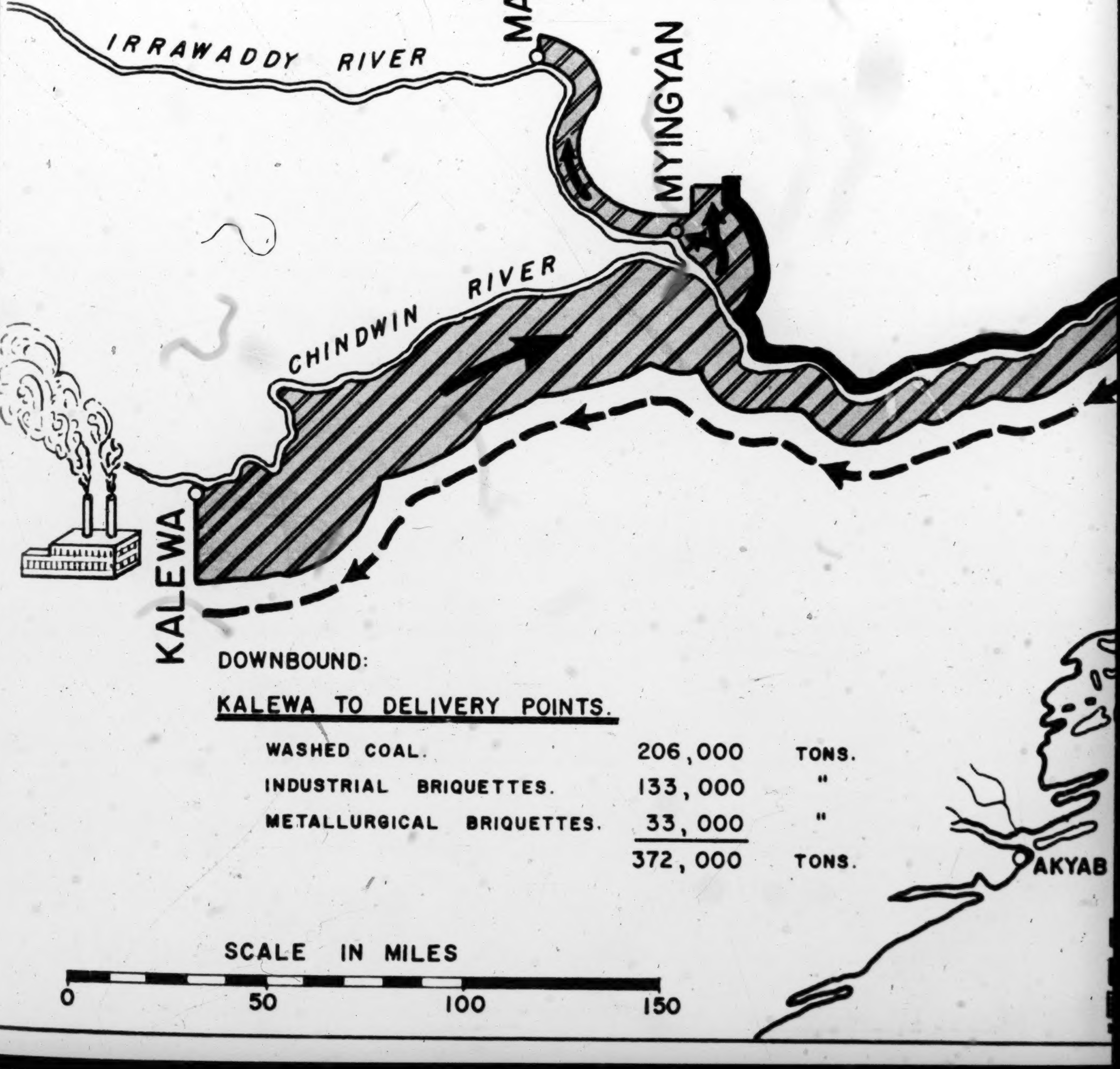
In this case 372,000 tons of coal would be transported annually from Kalewa down the Chindwin to Myingyan; 80,000 tons would be transported up the Irrawaddy to Mandalay and 148,000 tons would be unloaded at the Myingyan Industrial Site. The balance of 144,000 tons of coal plus 22,300 tons of zinc metal from the refinery and smelter at Myingyan, or a total of 166,300 tons, would be shipped from Myingyan to Rangoon. The only cargo on the return trip from Rangoon to Kalewa would be 7,775 tons of asphalt binder and coking coal, needed in the manufacture of industrial and metallurgical briquettes. This condition of return trip practically without

KALEWA TO MANDALAY.

WASHED COAL	20,000	TONS.
INDUSTRIAL BRIQUETTES	45,000	"
METALLURGICAL BRIQUETTES	15,000	"
	80,000	TONS.

KALEWA TO MYINGYAN.

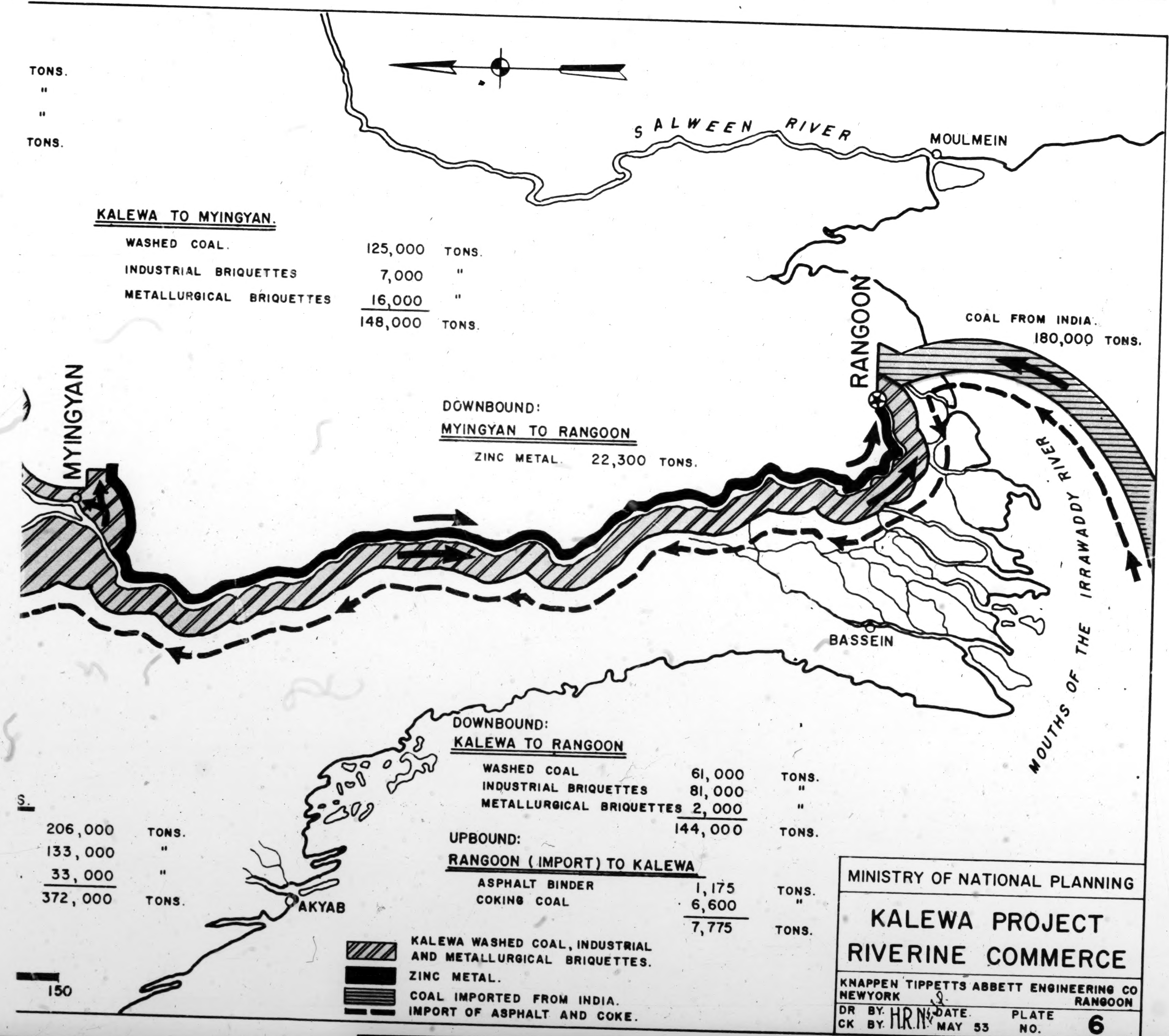
WASHED COAL.
INDUSTRIAL BRIQUETTES
METALLURGICAL BRIQUETTES


MANDALAY
IRRAWADDY RIVER
MYINGYAN
CHINDWIN RIVER
KALEWA
AKYAB
SCALE IN MILES
0
50
100
150

DOWNBOUND:

KALEWA TO DELIVERY POINTS.

WASHED COAL.	206,000	TONS.
INDUSTRIAL BRIQUETTES.	133,000	"
METALLURGICAL BRIQUETTES.	33,000	"
	372,000	TONS.


SALWEEN RIVER
MOULMEIN
RANGOON
MYINGYAN
BASSEIN
AKYAB
MOUTHS OF THE IRRAWADDY RIVER
150

TONS.
"
"
TONS.

KALEWA TO MYINGYAN.

WASHED COAL.	125,000	TONS.
INDUSTRIAL BRIQUETTES	7,000	"
METALLURGICAL BRIQUETTES	16,000	"
	148,000	TONS.

COAL FROM INDIA.
180,000 TONS.

DOWNBOUND:
MYINGYAN TO RANGOON
ZINC METAL. 22,300 TONS.

DOWNBOUND:
KALEWA TO RANGOON

WASHED COAL	61,000	TONS.
INDUSTRIAL BRIQUETTES	81,000	"
METALLURGICAL BRIQUETTES	2,000	"
	144,000	TONS.

UPBOUND:
RANGOON (IMPORT) TO KALEWA

ASPHALT BINDER	1,175	TONS.
COKING COAL	6,600	"
	7,775	TONS.

S.

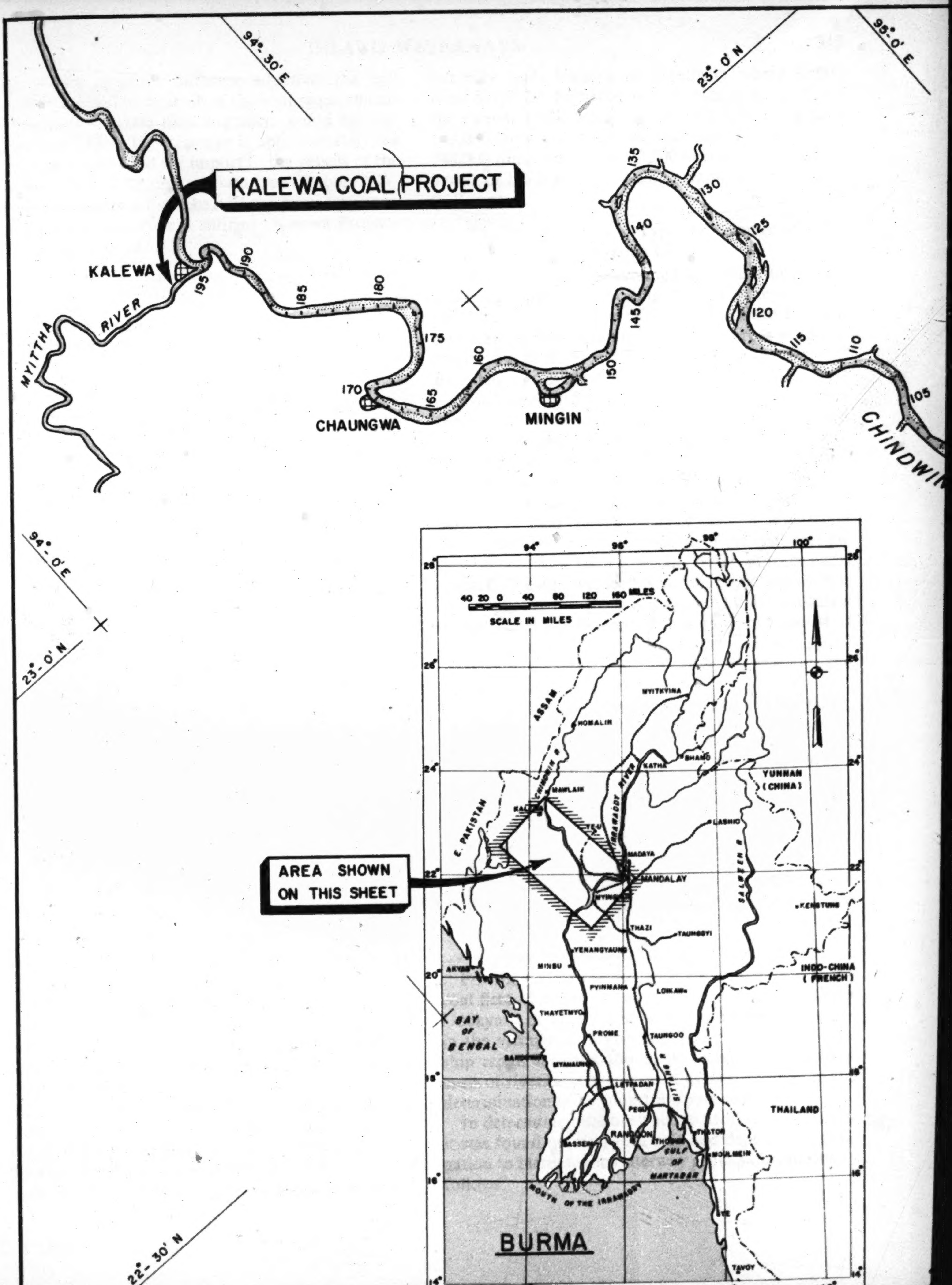
206,000	TONS.
133,000	"
33,000	"
372,000	TONS.

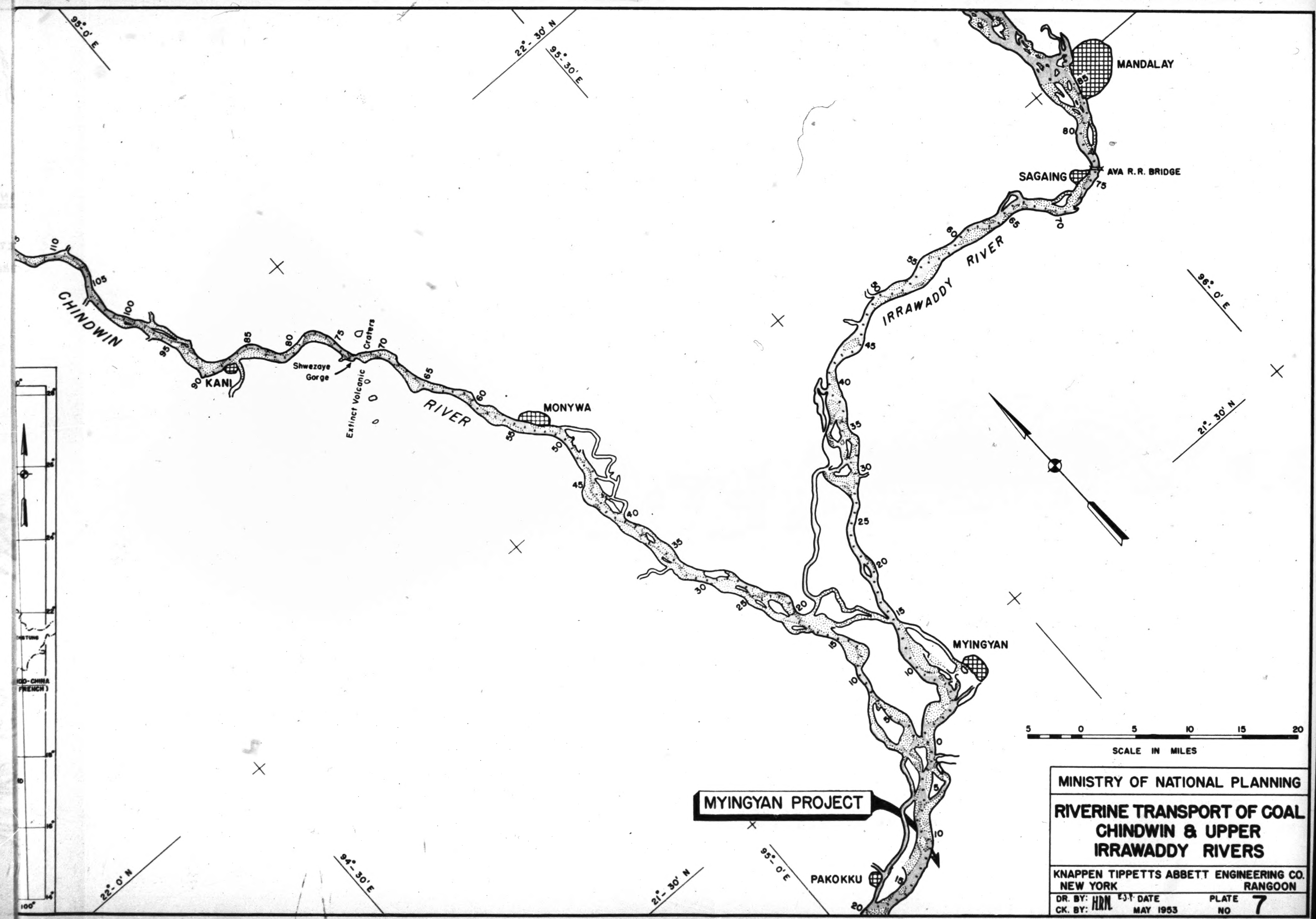
▨	KALEWA WASHED COAL, INDUSTRIAL AND METALLURGICAL BRIQUETTES.
■	ZINC METAL.
▤	COAL IMPORTED FROM INDIA.
▬ ▬	IMPORT OF ASPHALT AND COKE.

MINISTRY OF NATIONAL PLANNING

KALEWA PROJECT
RIVERINE COMMERCE

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEWYORK RANGOON
DR BY. HRN DATE.
CK BY. MAY 53
PLATE NO. 6


94° 30' E
95° 0' E
23° 0' N
KALEWA COAL PROJECT
KALEWA
MYITTHA
RIVER
CHAUNGWA
MINGIN
CHINDWI
195
190
185
180
175
170
165
160
150
145
140
135
130
125
120
115
110
105
94° 0' E
23° 0' N
22° 30' N
AREA SHOWN ON THIS SHEET
BURMA
40 20 0 40 80 120 160 MILES
SCALE IN MILES
94°
96°
98°
100°
28°
26°
24°
22°
20°
18°
16°
14°
ASSAM
E. PAKISTAN
YUNNAN (CHINA)
INDO-CHINA (FRENCH)
THAILAND
BAY OF BENGAL
GULF OF MARTABAN
MOUTH OF THE IRRAWADDY
CHINDWIN R
IRRAWADDY RIVER
SALWEEN R
SITTANG R
MYITKYINA
HOMALIN
BHAMO
KATHA
MAWLAIK
KALEWA
YEU
LASHIO
MADAYA
MANDALAY
MYINGYAN
KENGTUNG
THAZI
TAUNGGYI
YENANGYAUNG
MINBU
AKYAB
PYINMANA
LOIKAW
THAYETMYO
PROME
TAUNGOO
SANDOWAY
MYANAUNG
LETPADAN
PEGU
RANGOON
THATON
BASSEIN
THONGWA
MOULMEIN
YE
TAVOY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22°-30' N
95°-30' E
MANDALAY
SAGAING
AVA R.R. BRIDGE
IRRAWADDY RIVER
96°-0' E
21°-30' N
CHINDWIN
RIVER
KANI
Shwezaye Gorge
Extinct Volcanic Craters
MONYWA
MYINGYAN
PAKOKKU
MYINGYAN PROJECT
22°-0' N
94°-30' E
21°-30' N
95°-0' E
5 0 5 10 15 20
SCALE IN MILES

MINISTRY OF NATIONAL PLANNING

RIVERINE TRANSPORT OF COAL CHINDWIN & UPPER IRRAWADDY RIVERS

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY: HRN. E.J.T. DATE MAY 1953 PLATE NO 7
CK. BY: HRN.

cargo would naturally influence adversely the unit transport costs. The balance of the coal requirements of Rangoon, 180,000 tons annually, would be supplied from India. This tonnage is approximately the same as contemplated for import in the vessels of the Union of Burma Shipping Board (see Chapter XIV, Ocean Shipping). A flow chart of the preceding commerce is shown on Plate 6, entitled "Kalewa Project–Riverine Commerce."

(2) Riverine Transport of Foreign Coal to Myingyan Industrial Site

Should the development of Kalewa Coal Mines be found undesirable for economic or other reasons, the site of the planned industrial development probably would be moved from Myingyan nearer to the Rangoon–Mandalay railway line, with the power probably supplied from the hydroelectric development at Pyinmana. However, the cost of transport of imported coal to Myingyan should be determined for the purpose of comparison with the cost of coal transport from Kalewa to Myingyan. The annual quantity to be transported would be 148,000 tons.

(3) Rail Transport of Kalewa Coal

Kalewa has no rail connection. The nearest railway station is Zigon, on the existing railway from Mandalay to Myitkyina, about 92 miles north of Mandalay. The airline distance from Kalewa to Zigon is about 80 miles, but the rail distance would be about 102 miles because of the ruggedness of the terrain. The railroad at Kalewa could be established at the opposite or east bank of the Chindwin River and the transport over the Chindwin could be accomplished by an aerial tramway. The annual traffic from Kalewa to Zigon would be 372,000 tons of coal downbound and 7,775 tons of asphalt binder and imported coking coal upbound. This traffic of 379,775 tons would serve as the base for a determination of the unit freight rate out of which should be paid the annual costs and charges of construction and operation of the new railway. From Zigon to Mandalay and southward to Rangoon the traffic would move over the existing lines of the Burma Railways at a cost in accordance with established rates. However, should the economics justify the construction of the new rail line from Kalewa to Zigon it would be more prudent not to develop the Myingyan industrial area but rather to locate the zinc smelter and other industries closer to the raw materials and on the existing railway system. This report considers that Thazi, a railway station about 75 miles south of Mandalay, would be a suitable development location and it was to be used in the following investigations as a substitute site.

The 372,000 tons of coal then would be transported annually from Kalewa to Mandalay where 80,000 tons would be unloaded. From Mandalay to Thazi the annual traffic would be 292,000 tons. At Thazi, 148,000 tons would be unloaded and the remaining 144,000 tons of coal plus 22,300 tons of zinc metal, or a total of 166,300 tons, would be transported annually to Rangoon.

d. Determination of Type and Number of Riverine Craft

Detailed analyses determined that the critical navigating conditions controlling the size of tows would be in the Chindwin River from its mouth to Kalewa, and that the most economical size of barges would be 150 ft. by 30 ft. by 6·5 ft. The carrying capacity of these barges would be between 140 tons at 2·5 ft. draft and 440 tons at 5 ft. draft. For the purpose of this study the average carrying capacity was determined as 280 tons per barge on the Kalewa–Myingyan–Mandalay section and 312 tons on the Myingyan–Rangoon section. Plate 7, entitled "Chindwin and Upper Irrawaddy Rivers," shows the upper waterways to be used for transport of coal. It is assumed that by the time of the acquisition of the coal fleet the experiments with push towboats, referred to in paragraph C–1–e–(2), will lead to definite conclusions. For the purpose of this study it is assumed that twin-screw pusher boats will be used. The tows would consist of two barges on the Kalewa–Myingyan and Myingyan–Mandalay sections and of four barges on the Myingyan–Rangoon section.

The number of barges and towboats, with spares, required on various transport sections, was determined as follows:

	Barges	*Towboats*
Kalewa to Mandalay	10	5
Kalewa to Myingyan site	24	13
Myingyan to Rangoon	22	6
	—	—
Total	56	24

For the delivery of the imported coal from Rangoon to Myingyan the fleet should consist of 18 barges and five towboats.

e. Fleet Maintenance and River Conservancy

For the proper maintenance and fabrication of the coal fleet, it would be necessary to expand the Dalla Dockyard of IWTB and to provide a new boatyard in the vicinity of Myingyan. The cost of these new ship repair facilities should be included in the total costs of riverine coal transport as an increment in the determination of the unit transport costs.

In determining the most economical sizes of barges it was found necessary for safe and dependable navigation to increase the waterway project dimensions as follows:

	Existing		*Proposed*	
	Depth (ft.)	*Width (ft.)*	*Depth (ft.)*	*Width (ft.)*
Irrawaddy River, between Rangoon and Myingyan project site	4·5	150	5·5	190
Irrawaddy River, between Myingyan project site and Mandalay	4·5	150	5·0	150
Chindwin River, between mouth and Kalewa	3·5	100	4·0	130

The channels will have to be widened on the inside of all bends; the extent of widening will be dictated by the degree of curvature of each bend. To provide and maintain the required dimensions of channels an additional conservancy fleet would be required and the first costs of this equipment should be included in the first costs of riverine transport. However, it is considered that the annual costs and charges of channel maintenance should be carried by the Government as part of the general costs of river conservancy, and should not be included in the annual costs of riverine coal transport.

f. Cost of Riverine Transport

(1) First Costs

The total first-cost investment for the coal-carrying fleet, additional ship-repair facilities and additional river-conservancy equipment are as follows:

	Kyats
Fleet	2,25,32,615
Boatyards	97,96,880
River Conservancy Equipment	1,91,07,000
Total	5,14,36,495

The proportionate costs of the fleet and of the boatyards for various transport sections, with distribution of local costs and costs in foreign currency, would be as follows:

	Foreign Costs (K)	*Local Costs (K)*	*Total Costs (K)*
Kalewa to Mandalay	32,79,290	20,96,650	3,53,75,940
Kalewa to Myingyan	89,53,665	70,61,980	1,60,15,645
Myingyan to Rangoon	71,96,290	37,41,620	1,09,37,910
Total	1,94,29,245	1,29,00,250	3,23,29,495
River conservancy	1,36,91,000	54,16,000	1,91,07,000
Grand Total	3,31,20,245	1,83,16,250	5,14,36,495

The corresponding first costs of the fleet, boatyards and conservancy equipment for the transportation of import coal from Rangoon to Myingyan would be:

	Foreign Costs (K)	*Local Costs (K)*	*Total Costs (K)*
Fleet	72,10,490	23,21,090	95,31,580
Boatyards	2,61,250	10,45,000	13,06,250
Total	74,71,740	33,66,090	1,08,37,830
Conservancy	34,23,000	13,54,000	47,77,000
Grand Total	1,08,94,740	47,20,090	1,56,14,830

(2) Annual Costs and Charges and Costs per Ton and per Ton-mile

The annual costs and charges consist of interest and amortization costs and of costs of operation, maintenance and overhead. The rate of compound interest of sinking amortization fund is 5% on foreign investment and 4% on local costs. The useful lives of floating plant and flotilla were estimated at 30 years and of the boatyard facilities at 25 years. The annual maintenance charges were based on 3% of the first cost of the fleet and 2% of the first costs of boatyards. On this basis the total annual costs and charges for various sections of water transport would be as follows:

Kalewa to Mandalay

Interest and amortization	K3,49,150
Operation, maintenance and overhead	K11,88,100
Total annual costs and charges	K15,37,250

Annual tonnage, 80,000 tons; mileage, 280 miles; ton-miles, 22,400,000.

Cost per ton	K19.15.
Cost per ton-mile	K0·0684.

Kalewa to Myingyan Industrial Site

Interest and amortization	K10,29,130
Operation, maintenance and overhead	K34,40,550
Total annual costs and charges	K44,69,680

Annual tonnage, 299,775 tons; mileage, 208 miles; ton-miles, 62,353,200.

Cost per ton	K14.91.
Cost per ton-mile	K0·0717.

Myingyan Industrial Site to Rangoon

Interest and amortization	K6,96,490
Operation, maintenance and overhead	K29,30,555
Total annual costs and charges	K36,27,045

Annual tonnage, 174,075 tons; mileage, 458 miles; ton-miles, 79,726,350.

Cost per ton	K20.84.
Cost per ton-mile	K0·0455.

Kalewa to Rangoon

Cost per ton (K14.91 + 20.84) = K35.75.

Cost per ton-mile $\frac{\text{K}35.75}{208 + 458}$ = K0·0537.

In the case of transport of imported coal from Rangoon to the Myingyan Industrial Site, the corresponding annual costs and charges and unit rates will be:

Rangoon to Myingyan Industrial Site

Interest and amortization	K6,88,690
Operation, maintenance and overhead	K25,92,575
Total	K32,81,265

Annual tonnage, 170,300 tons; mileage, 458 miles; ton-miles, 77,997,400.

Cost per ton	K19.27.
Cost per ton-mile	K0·0421.

g. Cost of Railway Transport

(1) First Costs

The first costs of the construction and equipment of a railway between Kalewa and Zigon were estimated for a single-track railway with five passing sidings and automatic signal system, with the rolling stock consisting of approximately 11 locomotives and 410 self-dumping cars of 18 to 20 tons capacity. The estimated costs are as follows:

	Foreign Costs (K)	*Local Costs (K)*	*Total Costs (K)*
Main line with sidings, signal system, buildings, bridges and appurtenances	3,43,78,740	1,96,02,330	5,39,81,070
Rolling stock and maintenance equipment	2,38,81,770	26,53,530	2,65,35,300
Total first costs	5,82,60,510	2,22,55,860	8,05,16,370

(2) Annual Costs and Charges and Costs per Ton and per Ton-mile

The annual costs and charges consist of interest and amortization and of operating and maintenance expenses, including overhead. For the purpose of amortization the useful lives of grading and buildings were assumed as 50 years, of tracks and bridges as 30 years, and of rolling stock as 20 years. The rates of interest and of compound interest of sinking amortization fund are the same as in the case of riverine transport. On this basis the total annual costs and charges are:

Interest and amortization	K53,91,310
Operation, maintenance, and overhead	K25,53,200
Total	K79,44,510

Annual tonnage Kalewa to Zigon, 379,775 tons; mileage, 102·1 miles; ton-miles, 38,775,030.

Cost per ton	K20.92.
Cost per ton-mile	K0·2049.

From Zigon to Mandalay, Thazi and Rangoon the cost of transport would be at the established rate of Burma Railways of about K0·0532 per ton-mile.

Accordingly, the cost of transport per ton will be:

From Zigon to Mandalay	K4.89
From Zigon to Thazi	K8.88
From Zigon to Rangoon	K25.22
From Kalewa to Mandalay	K25.81
From Kalewa to Thazi	K29.80
From Kalewa to Rangoon	K46.19

h. Comparison of Costs of Riverine Transport and of Rail Transport

In the following tabulation only the transport costs are shown; neither the loading nor unloading costs are included. The site of the zinc smelter and refinery is assumed to be at the Myingyan industrial site in the case of riverine transport and at Thazi in the case of rail transport.

	By Rail (K)	*By River (K)*
First-cost investment	8,05,16,370	5,14,36,495
Transport costs		
Kalewa to Mandalay	25.81/ton	19.15/ton
Kalewa to Zinc Smelter	29.80/ton	14.91/ton
Kalewa to Rangoon	46.19/ton	35.75/ton

i. Conclusions

The above tabulation indicates that, when the Kalewa and Myingyan projects develop, transport of most bulk products should be by water. The funds required for the acquisition of the necessary coal fleet and of additional marine repair facilities are included tentatively in the program of expenditures of IWTB for capital investments in the fiscal years 1953–54 to 1961–62. However, the following should be noted:

The cost of riverine transport of imported coal from Rangoon to the Myingyan Industrial Site (K19.27 per ton) is higher than the corresponding cost of transport of Kalewa coal. It appears evident that it would be more economical to supply the Myingyan area and upper Burma with Kalewa coal than with the imported foreign coal. Whether Rangoon would be supplied with imported coal or with Kalewa coal would depend on the total cost of the coals in stockpile at Rangoon.

2. TRANSPORT OF PETROLEUM FROM CHAUK TO RANGOON

a. General

It was estimated that by 1959–60 domestic requirements of Burma for petroleum products would approximate 98,000,000 gallons per year and to meet this demand a crude oil production of at least 8,000 barrels per day would be required. Further development of production from fields which could be served either by pipeline or by riverine transport could increase the total output to 10,000 barrels a day. The planned capacity of the refinery at Chauk is 2,500 barrels per day and this refinery could be used to serve the needs of upper Burma. The balance of the production would then be transported to Syriam where it would be necessary to rebuild a refinery with a capacity of 7,500 barrels a day. Another possibility would be to abandon the refinery at Chauk, to transport all production to Syriam, to refine it there and then to ship by railway to upper Burma the petroleum products it needs. In this case the capacity of the refinery at Syriam would be 10,000 barrels a day.

A separate project report entitled "The Transport of Petroleum" presents a detailed comparative analysis of transport of both 7,500 and 10,000 barrels per day from Chauk to Syriam by waterways and by pipeline, the type and cost of required riverine fleet, the cost of reconstruction and of new construction of the pipeline and the comparative rates of petroleum transport by water and by pipeline. A brief summary of the findings and conclusions of this project report is presented in the following discussion. Plate 8, entitled "Petroleum Pipeline," shows the pipeline and waterway routes.

b. Determination of Type and Number of Riverine Craft

Detailed analyses determined that the most economical dimensions of barges for petroleum transport would be the same as those of the barges for coal transport or about 150 ft. by 30 ft. by 6·5 ft. However, the barges for petroleum transport would be of a closed type and would allow a smaller free-board. Consequently, the carrying capacity of the oil barges would be larger than that of the coal barges. For the purpose of this study the average carrying capacity of a barge on the Chauk to Syriam run was determined at 450 tons. It was further determined that the same type of twin-screw push towboats would be used as for the coal transport, and that the tows would be two barges long and two barges wide all rigidly lashed together, thus consisting of four barges with a total capacity of 1,800 tons per fleet unit. The number of barges and towboats including spares required for transport of petroleum from Chauk to Syriam, then would be:

	Barges	*Towboats*
7,500 bbl./day (375,000 tons/year)	22	6
10,000 bbl./day (500,000 tons/year)	31	8

c. Fleet Maintenance and River Conservancy

For proper maintenance of the petroleum fleet some expansion of the facilities of Dalla Dockyard would be required. Although the costs of this expansion were included in the first costs of the fleet for transport of Kalewa coal they are again considered herein, in case the transport of coal is not developed on the lower Irrawaddy. Should the coal commerce be developed and the costs of additional ship repair facilities shared between the coal and the petroleum transport, then the unit rates could be correspondingly decreased in both cases.

For safe and dependable navigation of the petroleum fleet there would be required the same modifications of channel project dimensions of the lower Irrawaddy as that found necessary for the operation of the coal fleet. As stated in section D–1–e of this chapter, the cost of the additional conservancy plant required to provide and maintain the modified channel clearances was charged to river conservancy.

d. Cost of Riverine Transport

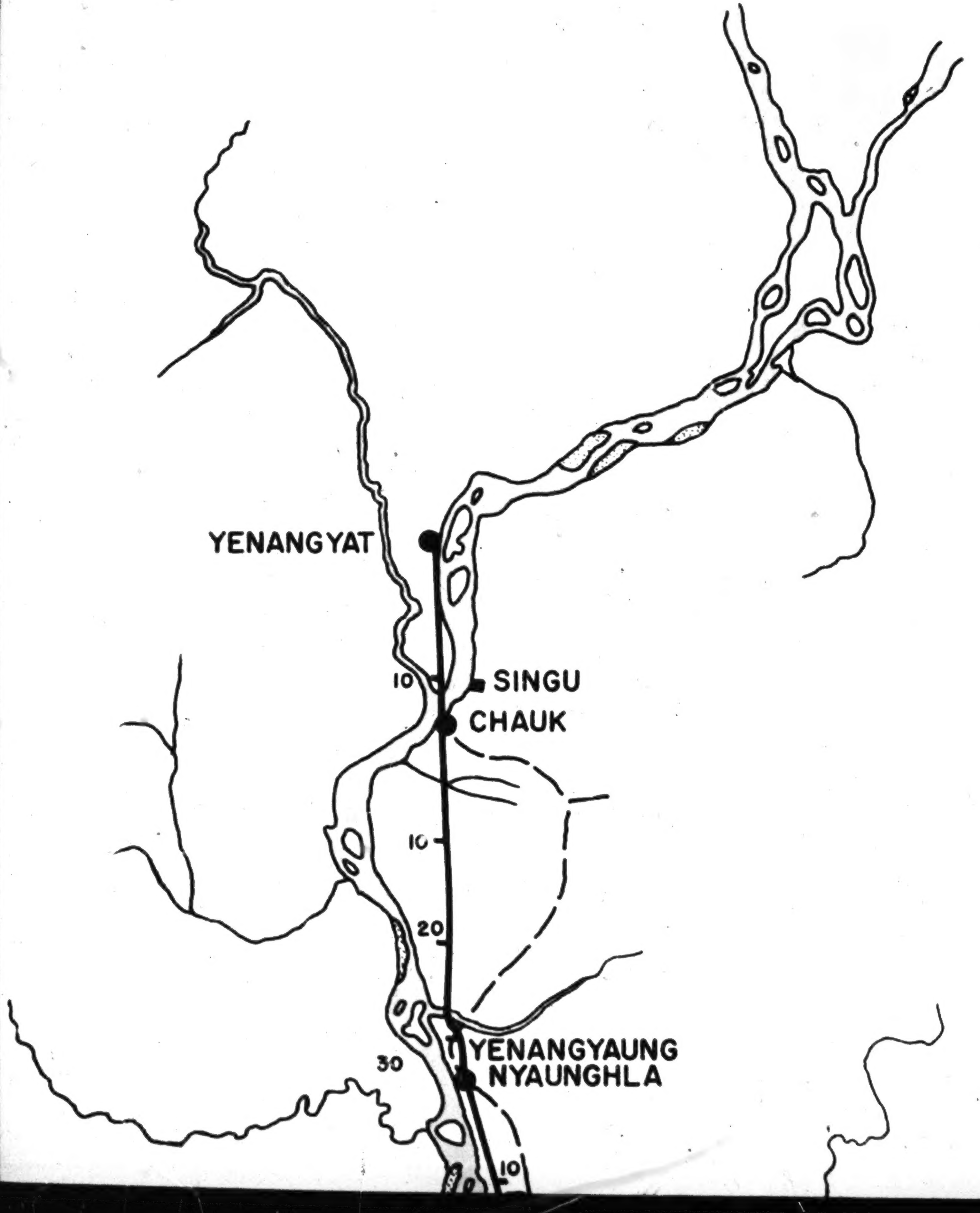
(1) First Costs

The total first costs of petroleum-carrying fleet and of additional ship repair facilities were estimated as follows:

	Foreign Costs (K)	*Local Costs (K)*	*Total Costs (K)*
375,000 tons/year			
Fleet	75,71,940	24,66,290	1,00,38,230
Dockyards	2,61,250	10,45,000	13,06,250
Total	78,33,190	35,11,290	1,13,44,480
500,000 tons/year			
Fleet	1,02,04,380	33,22,040	1,35,26,420
Dockyards	2,61,250	10,45,000	13,06,250
Total	1,04,65,630	43,67,040	1,48,32,670

(2) Annual Costs and Charges and Costs per Ton and per Ton-mile

The annual costs and charges of the petroleum fleet including interest, amortization, maintenance, operating costs and overhead were estimated on the same basis as the annual costs and charges of local handling fleet, as shown in Section D–1–f–(2) of this chapter.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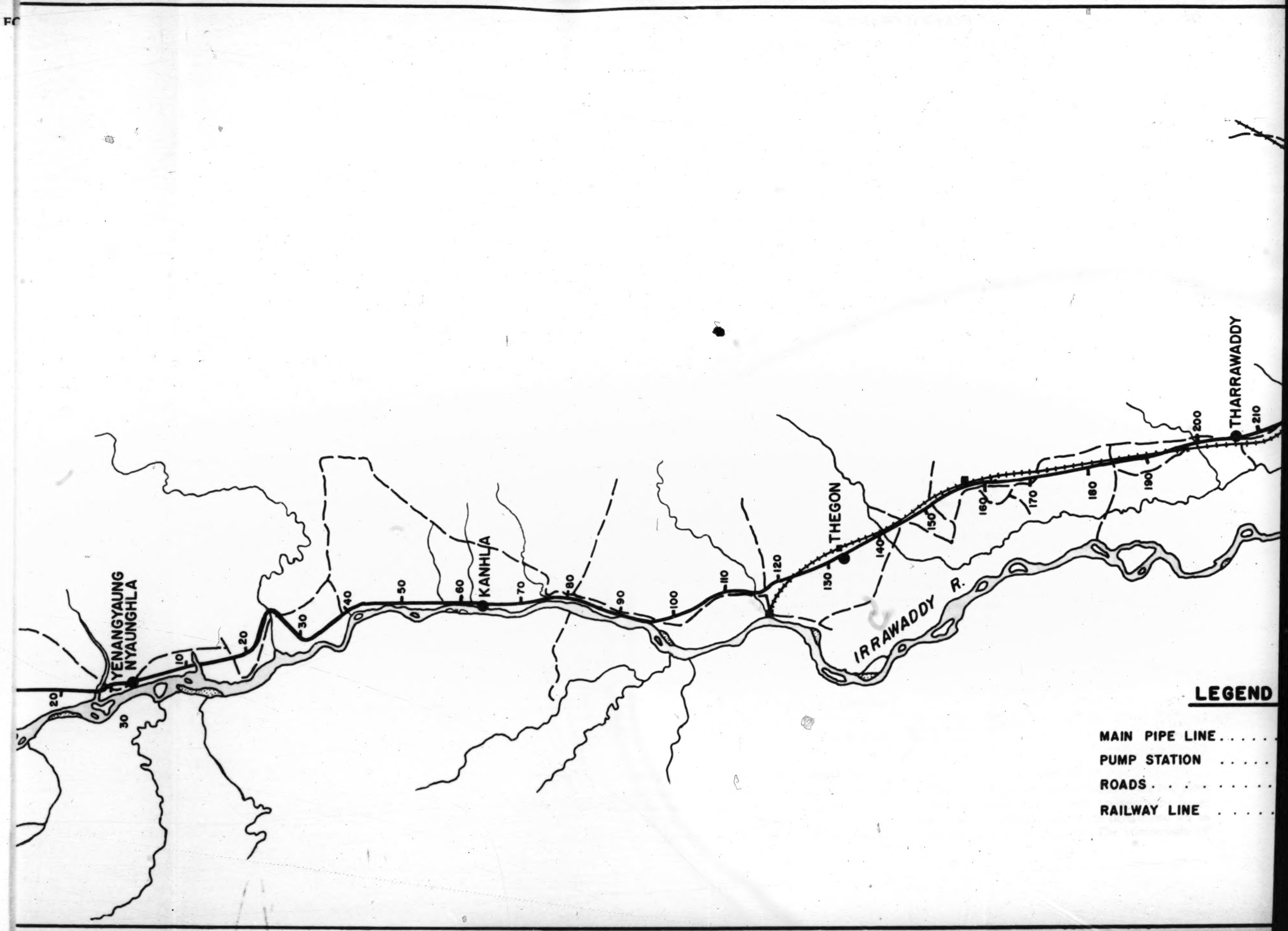
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LEGEND
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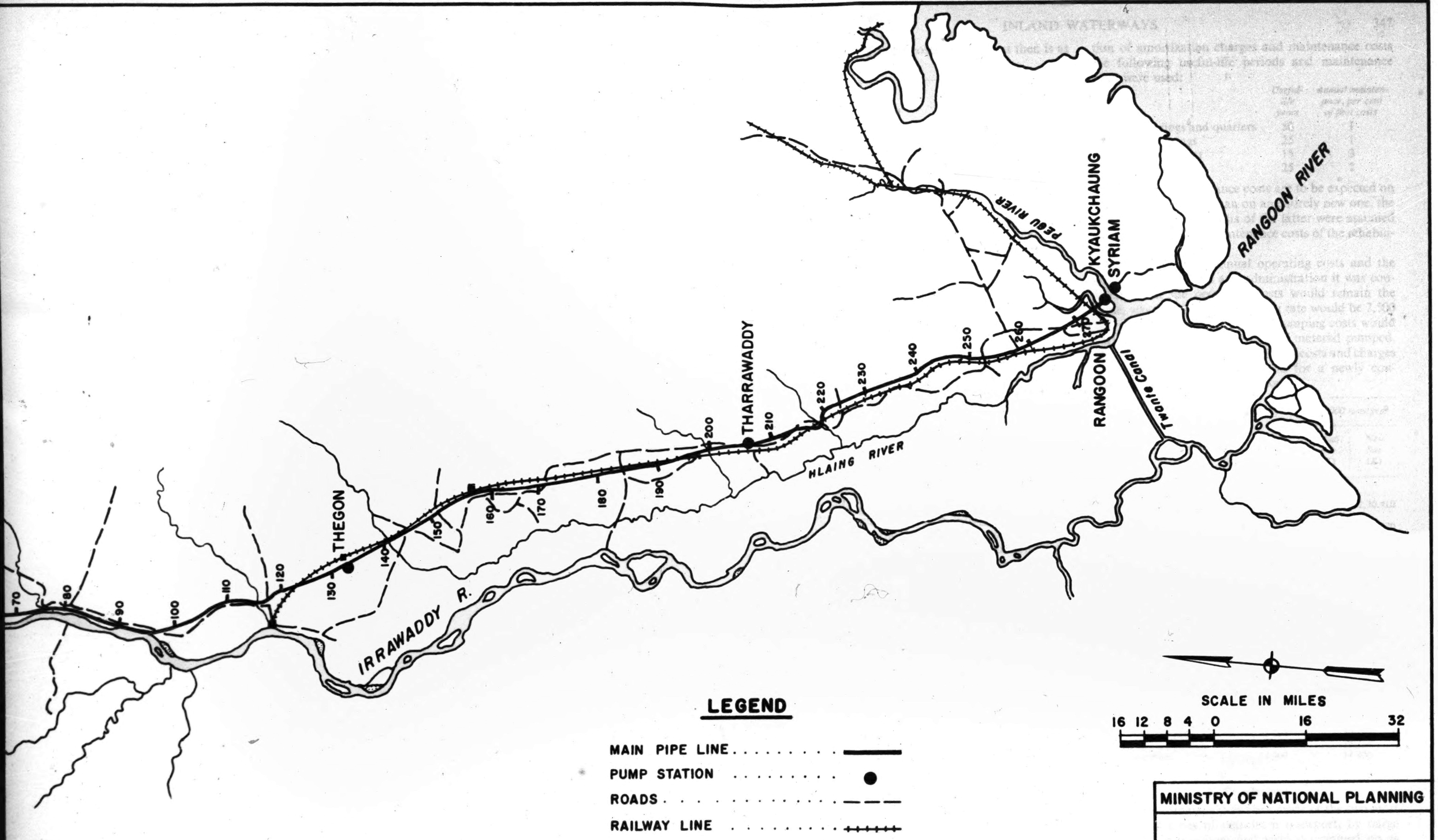
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SYRIAM
RANGOON RIVER
PEGU RIVER
RANGOON
Twante Canal
THARRAWADDY
HLAING RIVER
THEGON
IRRAWADDY R.
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LEGEND
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PUMP STATION
ROADS
RAILWAY LINE
SCALE IN MILES
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MINISTRY OF NATIONAL PLANNING

PETROLEUM PIPELINE

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK. RANGOON

DR BY. H.R.N. DATE MAY 53.
CK BY. PLATE NO. 8

The summary of these costs and charges then is as follows:

	375,000 tons/year (K)	500,000 tons/year (K)
Interest and Amortization	7,20,600	9,41,330
Operation, Maintenence, and Overhead	33,98,030	44,43,830
Toll Charges at Twante Canal	82,500	1,10,000
Total	42,01,130	54,95,160

The transport distance is 417 miles and the number of ton-miles would be 156,375,000 and 208,500,000 respectively for the two cases under investigation. The corresponding costs would be:

	375,000 tons/year (K)	500,000 tons/year (K)
Cost per ton	11·203	10·990
Cost per ton-mile	0·0269	0·0264

e. Transport by Pipeline

The oil pipeline from the fields at Yenangyaung and Chauk to Rangoon and Syriam was destroyed during the war. An exact survey of the damage was not made; however, it is considered that at least 50% of the line can be assumed to be destroyed as well as all plant and equipment, the majority of the buildings, and other facilities. Therefore, for the purpose of this study, two estimates of the costs of the pipeline were prepared. One estimate is based on the assumption that it would be necessary to rehabilitate 50% of the line, 95% of the houses and buildings and all of the plant, equipment and bridges. The second estimate evaluates the costs of the new construction of the entire line and of all appurtenant facilities.

f. Cost of Transport by Pipeline

(1) First Costs

The summary of the two estimates is as follows:

	Foreign Costs (K)	Local Costs (K)	Total Costs (K)
Rehabilitation of existing pipeline (cost per mile K1,28,390)	2,37,04,150	1,63,53,670	4,00,57,820
Construction of a new pipeline (cost per mile K1,92,600)	3,55,39,010	2,45,53,550	6,00,92,000

(2) Annual Costs and Charges and Costs per Ton

In estimating the annual costs and charges the interest rate as well as the rate of compound interest of sinking amortization fund was 5% on foreign expenditures and 4% on local costs; in the determination of amortization charges and maintenance costs the following useful-life periods and maintenance rates were used:

	Useful-life years	Annual maintenance, per cent of first costs
Houses, buildings and quarters	50	1
Pipeline and fittings	25	1
Plant and equipment	15	3
Bridges	25	2

Since greater maintenance costs are to be expected on the rehabilitated line than on an entirely new one, the annual maintenance costs of the latter were assumed at about 90% of the maintenance costs of the rehabilitated line.

In estimating the annual operating costs and the costs of management and administration it was considered that the personnel costs would remain the same, whether the daily pumping rate would be 7,500 bbl. or 10,000 bbl., but that the pumping costs would vary directly with the quantity of material pumped. On this basis the summary of annual costs and charges for the rehabilitated pipeline and for a newly constructed one would be as follows:

	375,000 tons/year		500,000 tons/year	
	Rehab. line (K)	New line (K)	Rehab. line (K)	New line (K)
Interest and amortization	29,12,800	42,70,910	29,12,800	42,70,910
Operation, maintenance and overhead	28,85,280	28,19,850	31,94,400	31,28,970
Total annual costs and charges	57,98,080	70,90,760	61,07,200	73,99,880
Cost per ton	15·462	18·909	12·214	14·800

g. Comparison of Costs of Riverine Transport of Petroleum and of Transport by Pipeline

	Cost per ton	
	375,000 tons/year (K)	500,000 tons/year (K)
By riverine transport	11·203	10·990
By rehabilitated pipeline	15·462	12·214
By new pipeline	18·909	14·800

h. Conclusions

The preceding analyses were made of the two most economical types of petroleum transport, by barge fleets and by pipeline, and were determined on as equitable a basis as possible. The comparison of transport costs per ton demonstrates that the riverine transportation of petroleum from the fields at Chauk is more economical than by pipeline, even though a new flotilla is compared with a rehabilitated pipeline.

An additional advantage of riverine transport is its flexibility. The fleet provided for the transport of petroleum from the upper Irrawaddy can be used on any of the major inland waterways of Burma. For the purpose of this study the sizes of riverine fleet were determined for transport of either 375,000 tons or 500,000 tons annually from Chauk to Rangoon. The funds required for the acquisition of this fleet are tentatively included in the program of expenditures of IWTB for capital investments in the fiscal years 1953–54 to 1961–62. However, the final size of the petroleum fleet would be determined by the extent of the development and the location of the new oil-fields.

E. PERSONNEL TRAINING PROGRAM

With the progressive rebuilding of the general-cargo and passenger fleet to prewar strength the Inland Water Transport Board would need additional qualified personnel of approximately the following classifications:

1. SHOP FOREMEN

In 1952 IWTB and ECA/TCA submitted firm requests for funds for overseas training for a foundry foreman, a galvanizing-plant foreman, and a diesel-shop foreman. With the termination of the ECA/TCA program these requests were cancelled and the necessary funds would have to be provided by IWTB.

2. INSTRUCTORS IN DIESEL ENGINEERING

To train additional diesel operators which would be required with the progressive increase of the number of diesel-powered craft.

3. MARINE ENGINEERING DESIGNERS

Structural (hull) and mechanical, who will then train the design force of IWTB in modern practices of ship design.

This program of training of technical personnel in Europe and in the United States already has been initiated by IWTB and its continuation and development are recommended.

In the handling of bulk cargoes such as coal and petroleum the method of transport would be by fleets of barges propelled by push towboats. Since that form of propulsion is entirely new to Burma, it would be necessary to train pilots completely in that form of transport and the recommended training program includes the costs of such instruction. Pilots' schools will be required and towing units used for practical training.

F. CONCLUSIONS

The foregoing considerations with respect to the operations of the riverine fleet lead to the following summary of conclusions and recommendations:

(1) The Inland Water Transport Board is a transport agency and should not be engaged in river conservancy operations.

(2) All marine shipbuilding and repair facilities should be merged under one department, the Department of Yards and Docks, and be administered through the Ministry of Transport and Communications.

(3) The Government should acquire the Arakan Flotilla Company, Ltd., and incorporate it in the Inland Water Transport Board.

(4) The IWTB's three-year and ten-year programs for rehabilitation of its fleet, together with a similar plan for rehabilitation of the river conservancy fleet is concurred in and should be prosecuted vigorously.

(5) To relieve the friction developed by misunderstandings with labor and to improve technical skills, educational instruction and training should be systematically provided.

(6) Facilities for landing, cargo handling and storage, at the main river ports on the Irrawaddy and Chindwin Rivers, should be improved insofar as justified by the increase in commerce requirements.

(7) When the Kalewa coal and the Myingyan industrial projects are developed, most bulk products should be transported by water.

G. ESTIMATED REQUIRED EXPENDITURES

The accompanying Table XIII–1 shows the estimated program of expenditures for capital investments and for personnel training. This program extends over ten succeeding years. The main costs are for the flotilla required in rehabilitating the prewar general-cargo and passenger fleet, and for the fleets required in the transport of the products of the proposed Kalewa coal development, the Myingyan industrial development, and for transporting crude oil from the producing fields in the Irrawaddy basin to the proposed refineries at Syriam. The investment costs of rehabilitating the dockyards and improving them for the fabrication and maintenance of the new vessels and craft are included in the table basically because they have been an incremental cost in the determination of transport unit rates. These expenditures would not be a part of the transport agency's operating costs, but would be diverted to the Department of Yards and Docks which was recommended in Chapter XII. In a similar manner the costs shown in the table for waterway conservation fleet and operations would be diverted to the operating costs of the Mercantile Marine Department.

TABLE XIII – 1

RECOMMENDED ANNUAL EXPENDITURES, INLAND WATERWAYS

(in 1,000's of kyats)

	Expenditure			*1st Yr.*	*2nd Yr.*	*3rd Yr.*	*4th Yr.*	*5th Yr.*	*6th Yr.*	*7th Yr.*	*8th Yr.*	*9th Yr.*	*10th Yr.*
	Total	*Foreign*	*Local*										
General-cargo and Passenger Trade													
Flotilla	15,00,00	11,50,00	3,50,00	1,00,00	1,50,00	2,00,00	2,00,00	2,00,00	1,75,00	1,75,00	1,50,00	1,00,00	50,00
Dockyards													
Dalla Dockyard	89,30	70,00	19,30	15,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	4,30	
Mandalay Dockyard	5,00	3,50	1,50	2,00	2,00	1,00							
Personnel Training	10,00	7,50	2,50	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Subtotal	16,04,30	12,31,00	3,73,30	1,18,00	1,63,00	2,12,00	2,11,00	2,11,00	1,86,00	1,61,00	1,05,30	1,05,30	51,00
Kalewa Coal Trade													
Flotilla													
Kalewa to Mandalay	38,08	28,87	9,21		3,08	9,00	9,00	9,00	8,00				
Kalewa to Myingyan site	70,45	53,41	17,04		10,45	15,00	15,00	15,00	15,00				
Kalewa to Rangoon	1,17,20	88,50	28,70		17,20	25,00	25,00	25,00	25,00				
Dockyards													
Dalla Dockyard	20,59	3,92	16,67	4,00	5,00	5,00	4,00	1,59	1,00				
Myingyan Industrial Site	78,37	19,59	58,78		15,00	20,00	20,00	15,00	8,37				
Conservancy Fleet	1,91,07	1,36,91	54,16	31,07	40,00	40,00	40,00	40,00					
Personnel Training	10,00	7,50	2,50	1,00	2,00	2,00	2,00	2,00	1,00				
Subtotal	5,25,76	3,38,70	1,87,06	36,07	92,73	1,16,00	1,15,00	1,07,59	58,37				
Petroleum Trade													
Flotilla													
For 375,000 tons/year	1,00,38	75,72	24,66										
For 500,000 tons/year	1,35,26	1,02,04	33,22	10,26	20,00	30,00	30,00	30,00	15,00				
Dockyard—Dalla	13,06	2,61	10,45	2,00	3,00	3,00	3,00	2,06					
Personnel Training	5,00	3,75	1,25	50	1,00	1,00	1,00	1,00	50				
Subtotal	1,53,32	1,08,40	44,92	12,76	24,00	34,00	34,00	33,06	15,50				
TOTALS:													
1. Passenger and Cargo Trade only	16,04,30	12,31,00	3,73,30	1,18,00	1,63,00	2,12,00	2,11,00	2,11,00	1,86,00	1,86,00	1,61,00	1,05,30	51,00
2. Passenger, Cargo and Kalewa Coal to Myingyan and Mandalay	20,07,86	14,77,70	5,30,16	1,52,07	2,36,53	3,02,00	3,01,00	2,93,59	2,19,37	1,86,00	1,61,00	1,05,30	51,00
3. Passenger, Cargo and Kalewa Coal to Myingyan, Mandalay and Rangoon	20,35,76	14,96,20	5,39,56	1,37,07	2,43,73	3,17,00	3,16,00	3,08,59	2,34,37	1,76,00	1,51,00	1,01,00	51,00
4. Passenger, Cargo and Petroleum Trade	17,57,62	13,39,40	4,18,22	1,30,76	1,87,00	2,46,00	2,45,00	2,44,06	2,01,50	1,86,00	1,61,00	1,05,30	51,00
5. Passenger, Cargo, Kalewa Coal to Myingyan and Mandalay, and Petroleum	21,53,12	15,86,99	5,66,13	1,64,83	2,59,53	3,34,00	3,32,00	3,24,59	2,34,87	1,86,00	1,61,00	1,05,30	51,00
6. Passenger, Cargo, Kalewa Coal to Myingyan, Mandalay and Rangoon and Petroleum	22,70,32	16,75,49	5,94,83	1,64,83	2,76,73	3,59,00	3,57,00	3,49,59	2,59,87	1,86,00	1,61,00	1,05,30	51,00

CHAPTER XIV

OCEAN SHIPPING

A. COASTAL STEAMSHIP SERVICES IN PREWAR AND POSTWAR PERIODS

1. PREWAR PERIOD

Before the war the following steamer services were operating between the seaports of Burma:

(*a*) Two steamship companies provided regular sailings twice a week between Rangoon and Chittagong, calling at the ports of Sandoway (Andrew Bay), Kyaukpyu and Akyab.

(*b*) Two coastal steamers were operated on a weekly service between Rangoon, Moulmein, Tavoy, Mergui and Victoria Point.

(*c*) The Straits Shipping Company operated a fortnightly service between Moulmein and Penang, calling at Tavoy, Mergui and Victoria Point.

2. POSTWAR PERIOD

Due to the loss of numerous vessels during the war and due to other causes it was impossible to re-establish the regular steamer services of the prewar period:

(*a*) On the Rangoon to Akyab run the commercial operators were reluctant to call at Kyaukpyu and Sandoway and it was possible to obtain only the irregular services of the British India Steam Navigation Company and others on the Rangoon–Akyab–Chittagong–Calcutta run.

(*b*) One of the coastal steamers was reinstated on a fortnightly service, Rangoon–Moulmein–Mergui, in 1946. This vessel was lost in 1947 and has not been replaced.

(*c*) The Straits Shipping Company extended its service to Rangoon and its vessel S.S. *Matang*, of about 1,470 gross tons, is the only vessel supplying scheduled service to the Tenasserim ports of Moulmein, Tavoy, Mergui and Victoria Point. This vessel makes a round trip between Rangoon and Penang approximately once in every three weeks.

Thus, in the postwar period there were no scheduled steamer services between Rangoon and Arakan ports and only one three-weekly service between Rangoon and the Tenasserim ports. The additional demand was partly covered by non-scheduled private operators often sailing with vessels of low safety factors.

B. INVESTIGATION OF NEEDS FOR STEAMER SERVICES

1. PRELIMINARY STUDIES

The needs for re-establishing regular coastal steamer services between Burma's seaports have been made still more pressing due to the restriction of all forms of land commerce since the beginning of insurgency. As there were no prospects that these essential services would be supplied by private shipping companies, domestic or foreign, their provision by Government was indicated. At the same time, a favorable possibility to enter the international shipping business presented itself to Government as a consequence of the nationalization of rice export trade. The government agency handling all rice export, the State Agricultural Marketing Board, sells rice f.o.b. One of the principal importers is India, which in turn supplies the coal imported in Burma by the Coal and Coke Agency for and on behalf of Government. Should the import coal and part of the export rice be transported in government-owned vessels, rice for India could be sold c.i.f., thus allowing a more favorable position in the world market. Simultaneously, transport of coal from India in Burmese vessels would produce savings in transport costs and in foreign exchange.

It could be reasonably estimated that even with the development of the indigenous Kalewa coal deposits and with the progressive dieselization of power, an annual import of not less than 150,000 to 180,000 tons of coal would be required. If a foreign commerce were established on the basis of importing that amount of coal and exporting a similar amount of rice the vessels would be guaranteed full cargoes for each trip, an ideal economic condition for transport.

In the realization of these benefits the Nautical Adviser reported to the Ministry of Transport and Communications in August and September 1951, recommending the organization by the Government of coastal services with three vessels and of rice-coal trade with India with four vessels. While it was indicated that the Burma-India steamship service would be a very profitable venture, it was pointed out that the operation of coastal service may show a temporary loss. However, the Nautical Adviser concluded that "what is of paramount importance is that services of this most essential nature will have been established under the direct control of the Government of the country and not be subject to the whims and fancies of outside influences."

2. RECOMMENDATIONS

The reports of the Nautical Adviser are concurred in, and it is recommended that the operations of proposed services be placed under a separate agency or a maritime board.

C. UNION OF BURMA SHIPPING BOARD

1. AUTHORIZATION

By executive order No. 75, dated June 6, 1952, to be called Union of Burma Shipping Board Order, 1952, the President established the Shipping Board responsible to the Minister of Transport and Communications and consisting of a full-time chairman and other members not exceeding ten, to be appointed by the President. As of June 1953 the Board consisted of four members, the chairman, the general manager, and one representative each of the Ministry of Transport and Communications and of the Ministry of Finance and Revenue. The Nautical Adviser and Principal Officer, Mercantile Marine Department, acts as adviser to the Board.

2. FUNCTIONS

According to the Executive Order "the functions of the Board shall, subject to the control of the President of the Union, be generally to regulate, maintain and operate coastal steamer service and steamer service between India and the Union of Burma, and to control the rates at which a vessel in such service, registered in the Union of Burma, may be hired and the rates at which persons or goods may be carried in such vessel, and the Board shall, subject to the control of the President of the Union, also undertake other activities necessary or expedient for the proper carrying out of its functions under this order."

3. ORGANIZATION

As of June 1953 the organization of the Board, under the direction of the general manager, consisted of the headquarters staff at Rangoon of about 50 persons and of about the same number of ship and field personnel. It is intended to nominate the port officers of the outports as agents of the Board, supplying them with a separate staff for the purpose. At Akyab the port officer, due to a heavy work load, was unable to take on additional duties and the Board nominated the senior pilot as its agent. At the ports which do not have port officers (as Kyaukpyu and Sandoway) the Board has its own full-time agents.

4. INITIATION OF COASTAL STEAMSHIP SERVICES

In July 1952 the Board acquired in Norway a second-hand vessel of about 1,420 gross tons. The vessel, renamed S.S. *Pyidawtha*, was rebuilt so as to accommodate 12 first-class passengers, 14 second-class passengers, some 350 deck passengers and cargo. The vessel arrived in Rangoon at the end of January 1953 and started the regular service between Rangoon and Akyab on February 10, 1953. It calls at the port of Kyaukpyu and at Sandoway except during monsoon season. A landing place to replace Sandoway during monsoon season will be provided in the near future. Bassein has not been made a port of call since it can be served adequately from Rangoon by the Inland Water Transport Board. A trip from Rangoon to Akyab and return requires about seven days, and the departures from Rangoon to Akyab take place about every ten days. The key positions on S.S. *Pyidawtha*, such as Master, First Officer, and Chief Engineer are manned by foreign personnel under three-year contracts. A similar arrangement probably will be necessary on future vessels of the Board until adequate Burmese personnel can be trained. Eventually all vessels will be manned by nationals.

5. PLANNED ADDITIONAL STEAMSHIP SERVICES

As of June 1953 the Board had on order two new coastal steamers of approximately the same capacity as S.S. *Pyidawtha*. Their delivery is scheduled for August 1954 and November 1954 respectively. It is planned to put one of the vessels in the Rangoon to Akyab service with the possible extension to Chittagong, East Pakistan. The other vessel will start the service between Rangoon and Tenasserim ports with possible extension to Penang should the circumstances warrant it.

For the Burma-India coal and rice trade the Board has on order two new vessels of about 8,000 gross tons. Their respective deliveries are scheduled for April 1954 and August 1954.

6. BUDGET

The total budget of the Union of Burma Shipping Board, as approved by the Board (but not yet approved by the Government), is K1,80,00,000 for fiscal year 1952–53, and K1,50,00,000 for fiscal year 1953–54.

D. CONCLUSION

It was indicated in the interim report that in order to improve the over-all economics of the shipping operations of the Board, investigations were needed of more efficient methods of loading of export rice and unloading of import coal for the purpose of reducing the handling costs and the turn-around time of vessels. The results of these investigations together with recommendations for the construction and operation of separate rice-handling wharves and a coal-handling wharf in the Port of Rangoon are presented in Chapter XII. In the event that economic disadvantages prevent the use of the indigenous Kalewa coal in the Rangoon trade area, it is recommended that the Board at the proper time acquire such additional vessels for the Burma-India rice and coal trade as will permit the transportation of the entire tonnage of imported coal in government-owned vessels.

CHAPTER XV

PORTS AND WATERWAYS CONSERVANCY

A. INTRODUCTION

It has been shown in the preceding Chapters XII and XIII that the seaports and commercially navigated inland waterways of Burma are of extreme importance to the economic needs of the country. Foreign trade is necessary to the national and economic life. Since seagoing transport is the principal medium for shipping and receiving foreign goods, it is evident that the seaports and their entrance channels must be adequate to provide safe and dependable navigating conditions. The inland water-borne trade over the rivers and canals has long been and will continue to be a principal method of transporting freight between the principal cities, trade centers and seaports. The inland waterways, too, must be conserved, maintained and improved to insure efficient and economical handling of the nation's goods.

Because of the difference between the types and requirements of vessels engaged in coastwise and foreign commerce and the craft engaged in the riverine trade, conservancy activities may be divided into two groups, one dealing with seaports and the other with inland waterways.

B. CONSERVANCY FOR SEAPORTS

Except for the Port of Rangoon, the responsibilities of maintaining properly the project dimensions of the entrance channels and harbors of the seaports of Burma rest with the Mercantile Marine Department, under the Ministry of Transport and Communications. At the ports of Akyab, Bassein, and Moulmein the responsibility rests with a Port Officer who is assigned to each station by the Department. At these ports the Port Officer, assisted by the local District Commissioner who is responsible for the funds, maintains project depths and widths; provides aids to navigation; markers and buoys; provides harbor anchorage buoys and general-cargo handling facilities and furnishes vessel pilotage services. At the ports of Tavoy and Mergui the commerce does not yet warrant the assignment of a separate Port Officer, and conservancy is accomplished through the local District Commissioner under the general supervision and direction of the Nautical Adviser and Principal Officer, Mercantile Marine Department.

The Mercantile Marine Department maintains two dredges, buoy vessels, pilot vessels, hydrographic survey equipment and other necessary craft. Except for the dredges, all other equipment should be replaced at the earliest practicable date, and the estimated replacement costs of the necessary plant have been included in Chapter XII under the sections for the Ports of Akyab, Bassein, Moulmein, Tavoy and Mergui. The government boatyard at Dawbon is operated by the Mercantile Marine Department. It also operates a boatyard at Mandalay for the Upper Irrawaddy and Chindwin Rivers conservancy fleets, and is to construct as soon as practicable boatyards at the Ports of Akyab, Moulmein and Mergui. The subject of marine repair facilities has been discussed in the pertinent sections of Chapter XII, and the recommendation has been made therein to transfer these facilities to a Department of Yards and Docks. The costing of these facilities was included in Chapter XII.

Under the Rangoon Port Act of 1905, the Commissioners for the Port of Rangoon are responsible for maintaining, marking and lighting the entrance channel and the harbor; for pilotage of vessels entering, leaving or moving within the harbor area; and for providing and maintaining moorings and anchorages. The rehabilitation of the conservancy and pilotage fleet requirements were detailed in Chapter XII under the section on the Port of Rangoon, together with the estimated costs of conservancy.

C. CONSERVANCY FOR WATERWAYS

1. ORGANIZATION

While the marking and maintenance of river channels is the responsibility of the Mercantile Marine Department, it appears that other government agencies are active simultaneously in the general field of river regulation and maintenance.

In upper Burma, the Irrigation Department, Ministry of Agriculture, is concerned exclusively with the problems of irrigation; however, in lower Burma its responsibilities also include navigation and bank protection. The Irrigation Department at present owns and operates two dredges and other marine equipment and it is responsible for the maintenance of Twante Canal and of Pegu–Sittang Canal. Whenever a bank erosion endangers agricultural lands, the protective measures are the responsibilities of the Irrigation Department. However, when the erosion endangers a village or a town the necessary protective works are the responsibility of the municipality. In the case where actual work is carried out by the Irrigation Department the costs are paid out of local funds.

In several instances, particularly when the Irrigation Department experiences a shortage of manpower or equipment, the required work is carried out by the Public Works Department, Ministry of Public Works and Rehabilitation, with the costs charged to the Irrigation Department. Thus, in the Arakan area (according to the records of the Arakan Flotilla Company) river conservation in the Sandoway district was and is accomplished by Public Works Department forces. It consists principally in excavating shallow places during the low-water period, and clearing small creeks of sunken trees and snags.

The conservancy fleet and marine plant of the Mercantile Marine Department suffered severely during the war. Consequently, whenever necessary the Irrigation Department carries out the channel maintenance work, particularly in the Irrawaddy delta, at the request of IWTB and with the agreement of the Mercantile Marine Department. However, the combined equipment and efforts of all agencies are not sufficient at present to carry out the maintenance of inland waterways in an entirely satisfactory manner.

Although the marking of waterways apparently should be a function of the Mercantile Marine Department, it appears that it was also performed by the Irrawaddy Flotilla Company before the war and by the Inland Water Transport Board at present, as indicated by the following tabulation:

	1939	*1947*	*1950*	*1951*
Total number of vessels of I.F. Co. Ltd. and IWTB	679	617	534	531
Number of vessels assigned to river conservancy	98	87	54	81

As the above figures show, from 10% to 15% of the total number of vessels of the riverine fleet were assigned to "river conservancy". These vessels were engaged mostly in the marking of waterways, apparently in addition to similar activities of the Mercantile Marine Department.

2. PROJECT DIMENSIONS OF INLAND WATERWAYS

a. Existing Dimensions

The presently adopted project depths and widths of the navigated channels of the inland waterways of Burma are as shown in Table XV–1. These are the minimum clearances to be maintained during the low-water periods usually occurring in the period from December to May each year.

TABLE XV – 1

PROJECT DEPTHS AND WIDTHS OF NAVIGATED CHANNELS

	Minimum Depths	*Minimum Widths*
Irrawaddy—Rangoon to Mandalay	4 ft. 6 ins.*	150 ft.
Irrawaddy—Mandalay to Bhamo	4 ft. 0 ins.	100 ft.
Chindwin—mouth to Mawlaik	3 ft. 6 ins.	100 ft.
Chindwin—Mawlaik to Homalin	2 ft. 9 ins.	100 ft.
All Delta Waterways	5 ft. 6 ins.	150 ft.
All Arakan Waterways	5 ft. 6 ins.	150 ft.
All Moulmein Waterways	5 ft. 6 ins.	150 ft.

* The Nautical Adviser considers 5 ft. 3 ins. as being possible to obtain economically.

b. Proposed Project Dimensions

The existing project dimensions are adequate only for the prewar type of general-cargo and passenger trades; however, those limits would be inadequate for the safe and dependable operations of the fleets required in the proposed Kalewa coal development and the Myingyan industrial projects, and for the riverine transport of petroleum from the producing fields to the proposed refineries at Syriam. The project dimensions would have to be increased to comply with the requirements indicated in Table XV–2.

TABLE XV – 2

EXISTING AND PROPOSED PROJECT DIMENSIONS

	Existing		*Proposed*	
	Depth (ft.)	*Width (ft.)*	*Depth (ft.)*	*Width (ft.)*
Irrawaddy River between Myingyan site and Mandalay	4·5	150	5·0	150
Irrawaddy River between Chauk and Rangoon	4·5	150	5·5	190
Chindwin River between mouth and Kalewa	3·5	100	4·0	130

The channels will have to be widened on the inside of all bends; the extent of widening will be determined by the degree of curvature of each bend.

3. WAR DAMAGE AND REHABILITATION OF FLEET

The Mercantile Marine Department flotilla was almost completely destroyed during the war and the vessels acquired since are in poor condition. The Department has entered a plan for rehabilitation of their facilities the main items of which are additional dredges, snag lifters and rock pounders. It is proposed to use a total of four dredges for Moulmein and Arakan streams, for lower Irrawaddy, for Pakokku and Myingyan areas and for the Mandalay to Bhamo stretch of the Irrawaddy River.

These four dredges would be in addition to two dredges supplied under the United States assistance ECA/TCA program for use on the minor seaports. Six snag lifters and three rock pounders would be required for Chindwin and for Irrawaddy Rivers. At present there are in operation two snag lifters and one rock pounder. One salvaged dredge is being reconstructed at Mandalay boatyard. The Mercantile Marine Department is submitting to the Government a request for three additional dredges, four snag lifters and two rock pounders. Furthermore, the government boatyard at Dawbon is actively engaged in the construction of new launches and of other craft for the purpose of rehabilitating the conservancy fleet to its prewar strength.

4. MARINE REPAIR FACILITIES

The maintenance and repair of the conservancy flotilla and marine equipment is accomplished at their principal repair unit (government dockyard at Dawbon) and at the up-river yard at Mandalay. At Dawbon, across the Pazaundaung Creek from Rangoon, small-vessel construction also is accomplished. In Chapter XII there was included a detailed description of these facilities, the estimated expenditures required for modification, and the recommendation that all marine repair facilities in Burma, including those in operation by the Mercantile Marine Department, should be transferred to and operated by a new Department of Yards and Docks under the Ministry of Transport and Communications.

D. THE CONSERVANCY PROBLEM

1. SEAPORTS

At the port of Rangoon, the responsibility of conservation rests with the Commissioners for the Port of Rangoon. That organization understands completely the requirements and is capable of coping with the conservation problems. The conservancy of all other seaports of Burma is under the supervision of the Mercantile Marine Department, Ministry of Transport and Communications.

At the Ports of Akyab, Bassein and Moulmein, conservation is carried out under the direction of a Port Officer at each port who is in the employ of the Mercantile Marine Department. Since conservancy usually is accomplished with local funds the District Commissioners control the progress of conservation measures.

At the minor seaports of Tavoy, Mergui and Victoria Point, conservation is accomplished by the District Commissioners under the supervision of the Nautical Adviser and Principal Officer, Mercantile Marine Department. Local funds are used. In a similar manner conservancy is accomplished at the newly re-established ports-of-call for coastwise vessels at Kyaukpyu and Sandoway.

The functions and operations of seaport conservancy are well understood by the responsible agencies.

2. WATERWAYS

All inland waterways which serve the principal trade centers of Burma and which are essential to the transfer of goods between suppliers and market must be developed and maintained adequately to provide for safe and dependable navigating conditions. Project dimension depths and widths must be maintained, curvature of bends reduced, and channels marked plainly for both day and night navigation, whichever is required. In order to accomplish these requirements it is evident that the responsibility should rest with one department. However, under present conditions, the Mercantile Marine Department, the Irrigation Department, the Public Works Department, and the Inland Water Transport Board apparently all participate in waterway conservancy. In some instances it appears that the Mercantile Marine Department and IWTB are marking the same waterways. This overlapping and duplication of functions and responsibilities clearly indicates the need for the coordination of all activities pertaining to river regulation and conservancy, and their integration in a long-range river-control plan for all main navigated rivers of Burma.

3. FUNDS

In considering the rehabilitation of Burma's seaports and inland waterways it must be realized that the military activities of the past war destroyed almost all of the conservation flotilla and equipment, and that postwar conservation has been carried out primarily with makeshift equipment. The ports and waterways must be placed in safe operating condition and made ready to carry the normal trade when insurgency ceases. Therefore, the flotilla must be rehabilitated as soon as possible and the necessary conservation measures completed. As conservancy operations are not revenue bearing, except as carried out in the operations of the Port of Rangoon, it is necessary that Government provide the required funds under early appropriations. Waterways conservancy costs will continue as an annual Government cost. However, once the ports have been re-established as efficient working units, the maintenance at most of them can be accomplished under local and revenue funds.

The funds required for the conservancy of seaports are shown in Chapter XII. The funds necessary for waterways conservation are listed in Chapter XIII.

4. PERSONNEL TRAINING

In order to cope with conservancy problems, especially those in which hydraulic structures may be involved, it is important that qualified personnel be engaged to make the proper studies, analyses and designs, and supervise the construction. In a great number of instances critical shoals and bars, meandering channels, and other conditions requiring constant vigilance and dredging can be eliminated through the use of training walls or similar structures which should be designed only by engineers well versed in the subject. To encourage the development of a qualified group, inducements should be offered for completion of appropriate studies, and a program of advanced instruction provided by the university or by an educational contract.

E. CONCLUSIONS

The economy of Burma is affected materially by the operating efficiency of its seaports and waterways. Therefore, every effort must be expended to keep the channels in the conditions required for safe and dependable navigating conditions and for the efficient handling of commerce. To eliminate duplication, conservancy operations for water transport should be accomplished by one agency with no more exceptions permitted than such concentrated and interrelated operations as are conducted at the Port of Rangoon.

(1) It is therefore recommended that the responsibilities of maintaining the navigation channels to all other seaports and of the improvement and maintenance of the inland waterways, both natural and artificial, should be vested in the Mercantile Marine Department of the Ministry of Transport and Communications. Since river training and bank control is so closely related to the important problem of transport conservancy it is the natural conclusion that this same agency should be responsible also for those functions. The Mercantile Marine Department is well staffed with personnel trained in port channel and waterway conservancy, and, with the addition of personnel schooled in river hydraulics and river training, should be able to cope with all conservancy problems. This department should be the only one responsible for conservancy operations and the Irrigation Department, the Public Works Department, and the Inland Water Transport Board should not engage in those operations.

(2) To function efficiently in maintaining the channels, proper flotilla and operating equipment are required. The Mercantile Marine Department has evaluated the needs well, and early appropriations should be made by Government for these necessary expenditures.

(3) The Mercantile Marine Department at present maintains two boatyards, one the government dockyard at Dawbon and the other at the up-river station of Mandalay. In Chapter XII it was concluded that all marine repair facilities should be consolidated under a new Department of Yards and Docks. Therefore, the Mercantile Marine Department should relinquish those facilities and functions to the new department.

(4) The presently adopted inland waterway channel project dimensions appear adequate for the general-cargo and passenger trade vessels now operating. However, with the development of the Kalewa coal project, the Myingyan industrial projects, and the riverine transport of petroleum these project dimensions will require modifications as shown in Table XV–2 for the Irrawaddy River from Mandalay to Rangoon and on the Chindwin River from Kalewa to its junction with the Irrawaddy.

CHAPTER XVI

HIGHWAYS

A. INTRODUCTION

1. BASIC TRANSPORT NEEDS

Man strives, as he always has, for a wider and richer life, and all civilizations, ancient and modern, depend upon communication and transportation to achieve this end. In present-day life, the rapid and accurate transmission and interchange of information and the economical and rapid movement of goods of all kinds, and of travelers, is essential. The exchange of information, and of ideas, has become almost instantaneous as a result of the development of the telephone, the radio and other electronic systems. People and goods are now transferred from place to place by air, water, rail or by highway.

In Burma, as everywhere, highway transport cannot supplant the other means of transportation, some of which are much older in point of time. Here, the basic traffic arteries are the main rivers, especially the Irrawaddy and its main tributary, the Chindwin. Over these streams move great quantities of the bulk commodities of commerce and trade, rice and teak and coal and oil. During the last quarter of the last century, another mode of transport, the railroad, came to Burma, and the pattern of the complementary services began to emerge.

While the highways in Burma are very old, going back to the early times of mining in the upper portion of the Union, it is only in recent years, since the advent of the motor vehicle and the heavy truck for commercial haul, that they have developed and become sufficiently integrated into connecting routes to become an important part of the whole transport network.

Previous to the recent war, the total transport system was adequate for the limited needs of the Union. This is no longer true, for two reasons:

(*a*) The prewar facilities were so severely damaged during the war and the subsequent civil strife that many years may elapse before the physical conditions are restored to even approximately the prewar condition.

(*b*) Meantime, Burma's industrial, commercial and economic life has not stood still. Growth has been accompanied by the opening up of new areas, new industries and new needs. The deficit in total transport facility is very great, and must be eliminated if the cultural and economic life of the Union is not to be strangled.

The Government of the Union is in a unique and advantageous position with respect to its transportation system. It owns and operates the Burma Airways, the Burma Railways and the Water Transport Board; it builds the main highways of the country and regulates traffic thereupon, and it can guide and direct the development of the local road systems in all parts of the Union. It also possesses and administers the Road Transport Department. Government therefore has all of the essential means of transport within its own hands. From such a situation, with wisdom, can develop a fully integrated establishment, in which each of the modes of transport can develop fully within its own proper area, and in which fair competition between modes in overlapping areas results in adequate and economic transport for the entire Union.

2. HIGHWAY TRANSPORT IN BURMA

Each basic mode of transportation has its own advantages and shortcomings, and each is thus able to furnish economic and adequate service to some portion of the population, and for some commodities, better than any of the competing facilities. The existence of these areas of superiority, and their equality or even overlapping in some circumstances is due to many factors and some very complex relationships. Basically, water transport is cheap for bulk commodities; rail transport also hauls bulk commodities, but at a higher cost and higher speed; and highway transport enjoys great advantages of flexibility in routes and schedules either on short or long hauls. Low investment in fixed plant and equipment also contributes to the pre-eminent position of highway transport in many situations.

As previously stated, the river systems of Burma exercised a great influence on the development of transport. They have also had two influences upon the nature of the highway system. The primary one is that until quite recent times there were so few motor vehicles in the Union that this form of transport was largely an adjunct to the river shipping. Vehicles were used to bring freight shipments to the watercourses. There they were loaded and shipped by boat. World War II, however, brought the motor truck and many another heavy vehicle to Burma. They stayed to be used in a civilian capacity. Since that time there has been a phenomenal rise in the use of motor trucks and of passenger buses as means of bulk and mass transport.

At present, and this will go on into the future as well, the motor vehicle is a transport entity in itself, operating to haul passengers and freight between all parts of the Union and with little or no recourse to, or reliance upon, other modes of transport. On the other hand, it has aided in the re-establishment of the railroad freight traffic, so completely paralyzed as a result of the destruction of the war and the subsequent insurgent activities, and serves as a valuable feeder for Railways, especially in replacing links destroyed by the war and upon which the traffic is not sufficiently re-established to justify the relaying of track and the reconstruction of other demolished facilities. Similarly, though to a lesser extent, the motor truck brings much freight traffic to the shipping points in the river transport system.

The secondary effect of the river systems upon highways is really the effect of topography upon any facility which is essentially laid at grade and can cross water gaps only with difficulty and at a substantial expense. Through the years, for example, several fairly well-planned and built local highway networks have grown up in Burma, east and west of the Irrawaddy. But the existence of the large watercourse and the consequent cost of bridging it, have prevented the joining together of these local highway systems to form parts of a larger whole. In the whole length of the Irrawaddy, only the bridge at Ava afforded a crossing. This structure was partially demolished in 1942, and has not yet been put back into service. This kind of discontinuity and interruption to the continuous flow of traffic is costly, and is another hindrance to the commercial, economic and cultural growth of Burma.

Topography, too, has determined to a large degree the nature and general outline of the road system. The main highways, Routes I and II between Rangoon and Mandalay, extend generally north and south, along the edges of the level portion of the main "land mass," as defined by the Irrawaddy and Sittang Rivers. In general, the other main routes follow the watercourses in reaching higher altitudes, especially in upper Burma. The lack of adequate interconnections between the main routes, which are essentially north and south arteries, is to a large measure due to the mountain ranges between them, and over which road alignments with reasonable grades and horizontal curvature characteristics cannot be laid.

Burma, nationally and especially as to transport, is a nearly self-contained unit. The great central valley and the delta in lower Burma are encircled by mountain ranges and by the Shan Plateau. This "horseshoe" keeps the Union from significant intercourse with its neighboring states, except by sea and air. There are almost no open routes by land, although the growth of inter-country commerce will one day cause important highway arteries to be opened between Burma and Yunnan, Indo-China, Thailand and probably Pakistan and India.

3. PURPOSES OF REPORT

The purposes of this report on the highway transport system of Burma are:

(*a*) To trace its historical features, as affecting its present development.

(*b*) To examine the present system to establish its present condition.

(*c*) To study the entire network and to discover its inadequacies as to location, methods of construction and of upkeep in order that any shortcomings may be corrected.

(*d*) To establish the present density and pattern of traffic on the several parts of the system, to determine the present and anticipated future needs of the traffic.

(*e*) To examine the design requirements now being used on the several parts of the system, as measured against current highway engineering practices elsewhere, and to modify these as necessary for the present and anticipated needs of traffic.

(*f*) To study the need for, and costs of, mechanizing highway construction and maintenance operations in Burma.

(*g*) To review the 1907 Motor Code, with subsequent modifications, to determine its adequacy in the light of modern highway traffic and practices and to modify it as needed.

(*h*) To study commercial traffic and economic factors, and to make comparisons with other modes of transport in order that the process of integration of all modes of transport as envisioned in the preliminary report may be facilitated.

(*i*) To develop an improvement program, with proposals as to the sequence in which the several component parts should be carried out, and to compare the benefits to be derived against the cost of the work.

B. CLASSIFICATION

The 1950–51 Report of the Department, issued in 1953, carries the most recent figures as to the total mileages in the several parts of the highway system. The total mileage is classified by categories and road types in Table XVI–1 (*see next page*).

1. POLITICAL CATEGORIES

On the basis of governmental units, the road system may be classified as follows:

(*a*) Union highways, which are occasionally called national highways, are roads connecting the district

TABLE XVI – 1

NOTIFIED MAIN ROADS AND DISTRICT ROADS 1950–51

	Main Roads (miles)	*†District Roads (miles)*	*Total (miles)*	*Per cent*
Bituminous	1,847	233	2,080	26
Metaled	819	734	1,553	19
Surfaced	1,058	916	1,974	25
Earth	928	842	1,770	22
Mule Track	570	109	679	8
Totals for Union*	5,222	2,834	8,056	
	65%	35%		100

* Excluding the following notified Union Highways:

(*a*) Portion of Rangoon–Mandalay–Lashio–Bhamo–Myitkyina Union Highway lying in Shan States, 271 miles.

(*b*) Portion of Rangoon–Mandalay–Lashio–Bhamo–Myitkyina Union Highway lying in Kachin States, 167 miles.

(*c*) Myitkyina–Ledo road from Myitkyina passing through Shingbwiyang up to Pangsan Pass, 228 miles.

(*d*) Myitkyina–Sailaw–Sadon–Wanchon–Kaliang Hkyet (Kambaiti), 103 miles.

Rangoon–Mandalay–Lashio–Bhamo–Myitkyina Union Highway lying in Burma proper is 488 miles long and is included under main roads in the tabulation.

† District Roads include Deputy Commissioners Local Fund Roads.

capitals with important towns and cities in the districts and autonomous states of upper Burma. The entire cost of construction and maintenance for these roads is taken from the general revenue funds of the Union.

(*b*) Main roads are those lying in more than one district, and those connecting the township or subdivisional headquarters with the district headquarters. Most of these are motorable at all times of the year.

(*c*) District roads lie in only one district, although occasionally they will connect with a similar highway in the adjacent district. They are the responsibility of the district councils, and generally the funds for maintenance and repair are derived from local taxation and occasional grants from the Government.

(*d*) Municipal roads, sometimes called town roads, are those streets and roads falling within the limits of a local community. Generally, if carrying national and primary highways, their repair and upkeep cost is borne by Government.

(*e*) Village roads, which are generally cart tracks, are those whose maintenance is entirely a local matter, generally left to the voluntary efforts of villagers.

(*f*) Mule paths are seasonal roads in out-of-the-way villages and places, and are usable by pack animals and pedestrians only. No administrative responsibility is fixed for these, although some 570 miles of such construction are in the list of notified main roads, Table XVI – 1, and are therefore government-maintained.

2. PHYSICAL CATEGORIES

The Department, for its own purposes, classifies the vehicular roads on the basis of type of construction, as listed and described below:

(*a*) *Bituminous* (or "tarred," or "tar painted") which indicates that the traveling surface of the road has been treated or mixed with tar or bitumen.

(*b*) *Metaled*, or surfaced, road has a traveling surface composed of consolidated soling stone, crushed stone, laterite, or other similar hard aggregates, or combination of these, and placed to a substantial thickness.

(*c*) *Surfaced road* is a dry-weather road, with the traveling surface consisting of the natural ground which has been graded and upon which, in some cases, a thin layer of gravel has been placed.

(*d*) *Earth road*, not motorable, is not for motor vehicles, but only carts. If for non-vehicular traffic it is usually designated as a mule path, since it has no specific construction classification.

Table XVI–1 indicates that the total length of notified main roads, including that in the Shan and Kachin States, etc., is 5,991 miles, and for these the Government is responsible. The district roads, including those maintained from the Deputy Commissioners Local Fund, total 2,834 miles. One fourth of the total of main and district roads is of bituminous construction, another fourth is surfaced, one fifth is metaled, just over one fifth is earth construction, and the mule tracks total 8% of the whole.

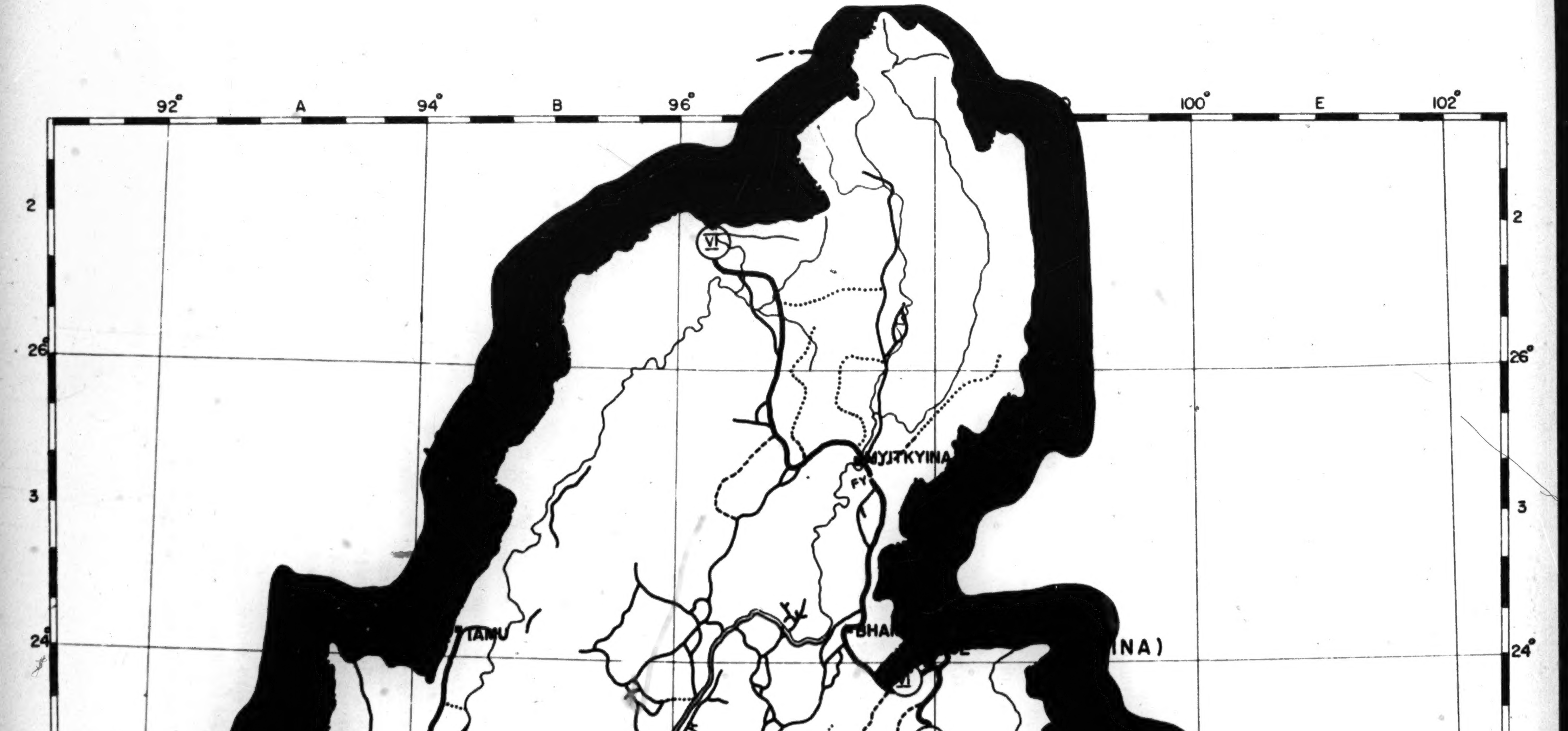
3. PROPOSED CLASSIFICATION

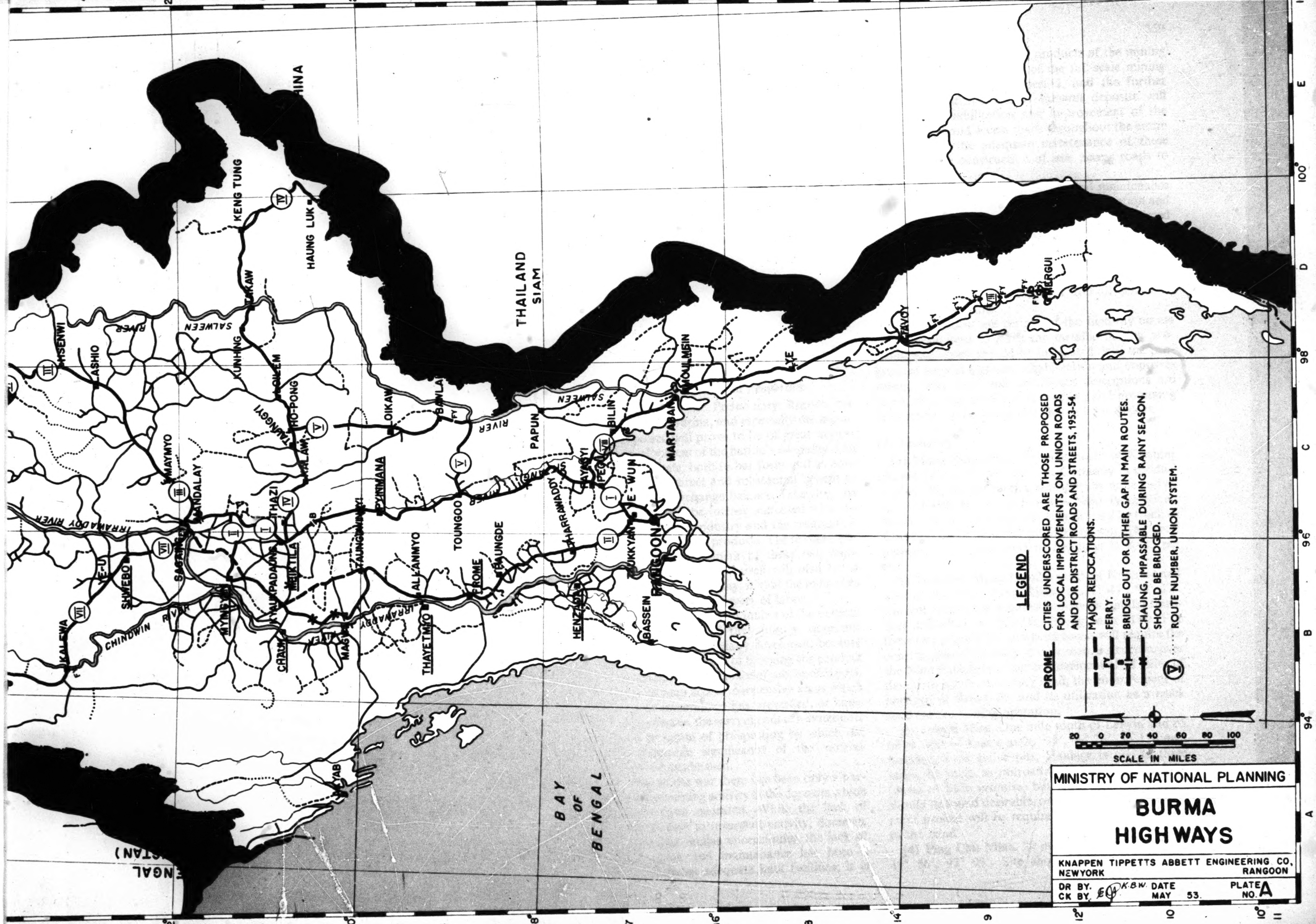
It is proposed in this Report, and for study and estimate purposes, to classify the highways on the following basis:

(*a*) *The Union road system*, having a measured total length of 3,231 miles, and consisting of the eight numbered national highways, Routes I–VIII.

(*b*) *The District road system*, comprising the roads in the several districts, and including also the more important secondary roads, largely tributary to national roads. The system is estimated to have a total length of 6,750 miles. The national and district road systems are further classified into rural and urban sections, and the programs and estimates in this Report are so prepared.

(*c*) *Farm-to-market roads*, in rural areas and generally planned to be constructed to give the small cultivator the chance to conveniently reach, by all-weather roads, other communities than his own. The system in its proposed development is estimated to total 3,750 miles in length.


92°
A
94°
B
96°
100°
E
102°
2
26°
3
24°
4
22°
VI
MYITKYINA
FY
BHAI
NA)
II
III
HSENWI
LASHIO
TAMU
KALEWA
FY
VII
YE-U
SHWEBO
CHINDWIN
RIVER
IRRAWADDY RIVER
VII
SAGAING
III
MAYMYO
MANDALAY
RIVER
WEEN
NGAL
STAN)


CHINA
KENG TUNG
HAUNG LUK
THAILAND
SIAM
HSENWI
LASHIO
SALWEEN
RIVER
KUNHING
LOILEM
HO-PONG
TAUNGGYI
KALAW
LOIKAW
BAWLA
MAYMYO
MANDALAY
IRRAWADDY RIVER
THAZI
MEIKTILA
PYINMANA
TOUNGOO
PAPUN
BILIN
MARTABAN
MOULMEIN
YE
TAVOY
MERGUI
SAGAING
SHWEBO
YE-U
KALEWA
CHINDWIN RIVER
MYINGYAN
KYAUKPADAUNG
YENANGYAUNG
CHAUK
MAGWE
ALLANMYO
THAYETMYO
PROME
PAUNGDE
THARRAWADDY
PEGU
PAYAGYI
KYAUKTAN
RANGOON
HENZADA
BASSEIN
AKYAB
BAY OF BENGAL
BENGAL
(PAKISTAN)
FY
I
II
III
IV
V
VII
VIII
4
5
6
7
8
9
10
11
22°
20°
18°
16°
14°
12°
10°
94°
96°
98°
100°
102
A
B
C
D
E
20
0
20
40
60
80
100
SCALE IN MILES

LEGEND

PROME CITIES UNDERSCORED ARE THOSE PROPOSED FOR LOCAL IMPROVEMENTS ON UNION ROADS AND FOR DISTRICT ROADS AND STREETS, 1953-54.

MAJOR RELOCATIONS.

FERRY.

BRIDGE OUT OR OTHER GAP IN MAIN ROUTES.

CHAUNG, IMPASSABLE DURING RAINY SEASON. SHOULD BE BRIDGED.

Ⓥ ..... ROUTE NUMBER, UNION SYSTEM.

MINISTRY OF NATIONAL PLANNING

BURMA HIGHWAYS

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.,
NEWYORK RANGOON

DR BY. K.B.W. CK BY.	DATE MAY 53.	PLATE NO. A

Plate A, Burma Highways, is a general map of the Union upon which have been shown the national, district and farm-to-market road systems, suitably distinguished. Certain of the more important relocations of the numbered routes are also designated.

(*d*) *Other roads.* There are a number of special-purpose roads to which consideration has been given and for which rough cost estimates were made in connection with the over-all program. Such roads as those into the timber-reserve areas, which are included with the project costs for the continuation and expansion of the timber-extraction industry; those into developed or exploratory mineral areas; those furnishing access to present or proposed irrigation, hydroelectric or industrial projects are classed under this general category. The total length is estimated roughly to be 1,400 miles since neither the scope nor magnitude of these special roads can be known until the development program begins to unfold. Of these roads, the ones to mineral properties are of special importance, and are treated separately below.

Access Roads to Mineral Properties

(1) As indicated in the Preliminary Report, the mineral resources of Burma, and especially the metallic mineral deposits, will prove to be of great importance in the development of the nation's economy. The export of these metals, both in bar form and as concentrates, will be of direct and substantial benefit to the nation's foreign-exchange balance. Likewise, the exchange balance will be further increased with the rehabilitation of the oil industry and the resumption of production of petroleum products. The re-establishment and further development of these two components of the resources of Burma will also be of benefit to the domestic economy, in that the industries will again become large employers of labor.

Previous to the recent war, a number of the mineral properties and deposits of the country were not developed, or were only partially developed, because of the inconvenience and cost of bringing the product of the mining operation to its place of use, or of export. Likewise, lack of road access to extensive areas which are known to be mineralized has prevented, or hampered to a large degree, the carrying out of a systematic and adequate program of prospecting by which the extent and economic significance of the various deposits could be established.

Since the end of the war there has been only a partial resumption of mining activity at the deposits which had previously been operated. While the lack of activity is due in part to insurgent activity, domestic insecurity and other similar uncertainties, the lack of road reconstruction and maintenance has been a major factor. Without adequate haul facilities, it is not possible to bring out the products of the mining operations. The resumption of the full-scale mining operations of the prewar period, and the further development of the known mineral deposits will require the rehabilitation and improvement of the principal haul and access roads throughout the entire mining areas, the adequate maintenance of these roads, and the construction of new access roads to potential mining areas.

While this highway construction and maintenance must be coordinated with the mining exploration and development programs, it must also be properly timed with respect to the general program of highway construction, which will be a continuing process during the next eight to ten years. It will be necessary that the corollary portions of the three programs be so carried out as to result in the maximum over-all benefit to the nation as a whole.

Outlined below are certain of the highway access projects required to serve the metallic mining program, and which should be integrated with the program of general highway rehabilitation and improvements. Only brief and identifying descriptions are given, since the details of the mining and processing features are to be found elsewhere in the Report.

(2) Antimony

(a) Mong Sang Mine. 26 miles north of Kunhing (Route IV), at 21° 41′, 98° 25′. Currently in production at 150 tons per month, transport by mule and ox cart to Wan Hpaka, across the Nam Pang River, thence over a very rough dry-season road by truck to Taunggyi or to railhead at Shwenyaung. The total transport cost from mine to Rangoon is K425 per ton.

(b) Nan Hok Mine. 35 miles north of Kunhing and west of the Nam Pang River, at 21° 47′, 98° 17′. Current production 100 tons per month, similar transport difficulties to those for Mong Sang Mine. For these two properties, improved access will require the construction of ten miles of new road, a structure over the Nam Pang River, the improvement of 18 miles of the north–south secondary road, the improvement of portions of Route IV, and its utilization as a truck road for the mining operation.

(c) Lebyin Mine. One mile south of Lebyin and 85 miles west of Kalaw at 20° 39′, 96° 26′, 30–120 men working, 8–50 active pits. Haulage is one to three miles, by road, to railroad. This property has been found of little promise, but if further development should be found desirable, only a small road improvement project will be required to improve the access to the mine.

(d) Ping Chit Mine. 20 miles north of Loikaw, at 19° 56′, 97° 09′. Site shows mining promise for development. If developed, it will be necessary to construct an access road (three miles), to construct a stream crossing and to improve a secondary road (six miles) west from To-Saikha (seven miles north of Loikaw on Route V).

(3) Tin and Tungsten

In addition to the tin and tungsten deposits in Tavoy, in other parts of the Tenasserim, and the Mawchi Mines, deposits of these two minerals occur in a number of other places in Burma. As for these other deposits, it will be necessary to further prospect and study these, to estimate the reserves, and to construct access roads into such of the sites as offer opportunity for economic development. Included in these deposits are the following:

(a) A group of four workings, north and slightly east of Thazi. The principal of these is the Nyaunggyat Mine at 21° 06′, 96° 13′. For the group, it will be necessary to construct seven to eight miles of new access road to Htandaw; and thence to improve the existing secondary road westward (including a bridge over Saman Chaung) approximately seven miles to Thedaw on the Railway, and 2½ miles farther to Route I. The latter is also being improved to Meiktila as part of the general road program.

(b) Palamon Mine, 20 miles east of Kalaw and to the west of Isle Lake, at 20° 37′, 96° 52′. To develop this property will require the construction of seven miles of access road, including a stream crossing, northward to the Railway and to Route IV, and the improvement of Route IV.

(c) A group of seven workings at Byinge (20° 01′, 96° 29′) and in this area (19° 36′, 96° 26′); at Hman Pyutaung (19° 37′, 96° 26′); at Kwedugyi (19° 50′, 96° 25′); at Padatygyaung (19° 40′, 96° 36′); at Kyat Pyin (19° 46′, 96° 33′); and near Nyenmatauk, at 19° 48′, 96° 27′. Generally these deposits are located 16 to 30 miles to the northeast and southeast of Pyinmana. Road work will be necessary to improve the access to such of these mines as are further developed under the tin-tungsten program. The Byinge Mine will require the improvement of approximately 17 miles of the secondary road extending eastward from Route I near Shwemyo, and the construction of a short section of new access road to the property, not more than 1½ miles in length. The Kwedugyi Mine if developed will require a one-mile access road, and the improvement of ten miles of the secondary road eastward from Yezin, on Route I. The other five properties are in general adjacent to and not excessively distant from the new Pyinmana–Loikaw road construction. Direct access is all that will be required in each case. The total length of this access construction is estimated to be 20 miles for the five properties.

(4) Zinc

In addition to the zinc operations at the Bawdwin Mines west of Lashio in the northern Shan States, the concentrates of which are processed at Namtu, a very large deposit of zinc carbonate has recently been discovered at the Lough Keng Mine, near Mong Pawn in the southern Shan States. The mine is located to the west of the Nam Pawn River, 18 miles south of Mong Pawn (29 miles east of Taunggyi on Route IV), at 20° 34′, 97° 25′. The rough reconnaissance and survey indicate an ore body of not less than one million tons. At present the mine is being operated at a rate of 200 tons per month. The ore is transported by mule from mine to road at a cost of K150 per ton, and the trucking to railhead and shipment to Rangoon totals K75 per ton. To develop this property to reasonable production will require the construction of an access from the mine northward to Mong Pawn and the improvement of Route IV westward through Taunggyi to the railhead at Shwenyaung.

(5) Manganese

During their occupation of Burma, the Japanese opened up a manganese deposit, but the mined ore was not refined or shipped, and some 3,000 tons is now stored at railhead at Shwenyaung. The material is of good grade, and is a very profitable exportable metal at the present time. The deposit is located at 20° 44′, 97° 15′, about six miles southeast of Ho-Pong village which is 9½ miles east of Taunggyi on Route IV. The development of the property will require the construction of an access road westward from the mine to Route V, and the improvement of the latter northward to Ho-Pong and that of Route IV westward to the railhead at Shwenyaung.

(6) Lead

Aside from the Bawdwin Mine, a very old and rich lead-silver lode appears to be an important metal resource of the Mansan–Taunggyi–Kalaw areas. The present mining activity is greater in the Mansan area, about two miles south of the village of Bawdwin (Mansan) and 16 miles northwest of Taunggyi. The largest properties are those of U Sit Han (producing 200–300 tons of ore per month) and the R.M. Aldworth Mine, just to the south (with an output of more than 300 tons per month). Other properties in the immediate vicinity average a total production of 600 tons per month. No explosives are used. The transport costs by truck from the mine to Rangoon total about K90 per ton.

The properties are centered at approximately 20° 55′, 96° 50′. There are other lead mines in the area such as the Bawzaing Mine, three miles southeast of the village of Mansan, which has a very substantial ore reserve; the Loi Kwang Mine, six miles south of Taunggyi; the Panzaw Mine, 21° 06′, 96° 33′; and at Kyaukmaung, 21° 13′, 96° 30′. For the U Sit Han and Aldworth properties and the Bawzaing Mine, it will be necessary to construct access road eastward from the deposits including a structure over Nanlet Chaung, and to improve the secondary road southward to the railhead at Shwenyaung. To serve the Loi Kwang property, it will be necessary to improve the secondary road north from the mine to Taunggyi, and Route IV westward to Shwenyaung. For the Panzaw and Kyaukmaung Mines, short access roads are needed, plus improvement of the secondary road southward into Aungban and Kalaw.

(7) The foregoing list of highway improvements required to furnish or improve access to mines includes only roads to major properties for the more important metallic minerals. Further investigation of other sources of these metals, and prospecting for other minerals in the various parts of Burma, will become necessary as the development program gets under way (these include possible beryl deposits north of Pyinmana; the chromites in the Arakan Yomas and northwest of Mogaung; the iron-ore deposits near Tavoy, northwest of Mandalay, southwest of Lashio, and possibly at Loilong, northeast of Bawlake; further tin-tungsten deposits in various locations especially in the Tenasserim). Some of the prospecting sited will require access and development roads. This highway construction, too, should be integrated with general highway rehabilitation and development in order to keep the entire program in balance.

While accurate estimates of tne construction cost of these latter development roads cannot be made at this time, the over-all total will be of the same magnitude as that estimated for the known metallic mineral deposits.

As part of the general survey for the economic development of Burma the rehabilitation and further development of the petroleum industry was investigated. In the "Report on the Economics of the Petroleum Industry in the Union of Burma," certain areas have been recommended for more complete prospecting and economic study. The likely areas are generally in the Magwe-Chauk region and in the lower Delta. The program is expected to extend over several years, and the estimated cost of K45,00,000 includes the necessary construction of access roads.

C. EXISTING HIGHWAY SYSTEM

1. HISTORICAL

The road system of Burma extends far back into history. In 206 BC, parts of it, in primitive form, served the early Chins and Chinese who were then working the amber mines near Mogaung, west of Myitkyina. The gem mines at Mogok were served by a 60-mile road from what is now Tabeikkyin, on the Irrawaddy. The jade deposits in the Kachin Hills are known to have been operated as early as 100 BC, and the trade routes from there into China, where the stones were cut, were regularized around 1750–1800.

The lead-silver mines at Bawdwin were worked by the Chinese from approximately 1400 until 1868, when they were abandoned as a result of the Mohammedan uprisings in Yunnan. In 1900 European interests again reopened the workings, and the private carrier rail line into Namtu was then built. Earlier the minerals and ores had been brought out by mule and cart over several routes into China, the principal one being via Hsenwi and on eastward, along the valleys of the Nam-Nam and Nam-Ting Rivers.

The tin-tungsten mines at Mawchi in the Kayah State have also been operated for a long period. In old times, the ores were taken out by mules over trails, leading to the Salween at Kampayu, and thence by country boat to Kyauknyat, thence by mule transport overland to Papun, and from there by country boat to Moulmein. With the completion of the Rangoon–Moulmein rail line, the trip from mine to port took about nine days. In 1934 a new road was constructed, and the material traveled via Loikaw and Taunggyi to the railhead at Shwenyaung. The trip over this route took about three days. In 1937 a private road was opened between Mawchi and Toungoo, to serve the mine. The new route makes Mawchi about 280 miles, by road, from Rangoon and the driving time by car is about 14 hours. Here again, the ultimate route was a highway replacing the earlier mule-team-river route from the mine to the port.

To a large degree, the development of the roads in northern and eastern Burma has followed the same pattern. Early trails led to waterways, these were joined together through the years, and finally the routes became of such length that they joined major towns and villages. Still later, as the motor vehicle came to Burma, the primary and more traveled routes were surfaced.

In southern Burma, the rice and farm area, the development has been related more to shipping. In old times Pegu was the major shipping port for a large area thereabouts. As the building of the delta forced the river mouth farther and farther to sea, the influence of Pegu diminished, and this was accompanied by an increase in the importance of shipping on the Irrawaddy River, especially at Prome and Henzada. The latter was at one time also an ocean port, but it too has been left inland by the building of the delta. In the period since the middle of the 18th century Rangoon, which was at that time a fishing village called

Dagon, became the pre-eminent port of the nation. The water transport routes, and later those by land and rail, branched out to join these commercial and shipping centers. In the delta, however, this development was always arrested, and even prevented, by the extreme cost of constructing through land routes over the numerous streams and in poor foundation material.

The lower network, then, developed to connect Rangoon to the ports along the Tenasserim; to Pegu and Prome, the latter later extending via Magwe into Mandalay. Route I, north from Pegu, gave convenient through routes from Rangoon to the eastern portion of Burma via Toungoo and Meiktila, and on into Thailand and Indo-China. Tributary roads developed west of the Irrawaddy also, especially in the Henzada area and around Pakokku.

In 1894 a Public Works Department was established and the responsibility for the construction and maintenance of the main highways was entrusted to that body. After the recent war, the Department became known as the Building and Roads Department, and is now in the Ministry of Public Works and Rehabilitation.

During the war, for military purposes, several important links were added to the highways of Burma. The Japanese opened up, although on a very crude and makeshift basis, several routes into Thailand. The portion of Route VI north and west of Myitkyina was constructed and surfaced as the Ledo Road by the United States Army, to be a supply line into the area from India eastward over existing roads into Yunnan. Also, the British reconstructed in 1944–45, for military supply purposes, the westerly portion of Route VII, from Kalewa to Tamu, at the Assam border. The portion of Route IV between Kengtung and the Thai border, a distance of 90 miles, was graded and graveled by the Siamese between 1942–45, while they occupied this portion of Burma.

The railroad to Ye was destroyed during the war, and the semi-permanent secondary road which existed between Thanbyuzat and Ye at that time has since been metaled with local material. The bridges along the route, constructed by the Japanese, were crude and inadequate and are being replaced by permanent crossings.

At the close of formal hostilities in 1945, the highways as a whole were in very poor condition because of the incessant pounding by all adversaries during the conflict. Insurgency, too, took its toll in destruction, especially during 1949–50. Neither the reconstruction nor the very necessary maintenance has taken place since that time. These are the basic problems which must be faced during the program which lies immediately ahead.

2. PRESENT MILEAGES

The national system of highways in Burma consists of eight numbered routes, having a total length of 3,231 miles. They are designated and have lengths and distances between larger communities as follows:

Route I Rangoon–Mandalay (east)

	Miles	
Rangoon		
	53	
Pegu		
	11	
Payagyi (Jct. VIII)		
	113	
Toungoo (Jct. V)		
	69	
Pyinmana		
	91	
Meiktila (Jct. IV)		
	51	
Ye-Wun (Jct. II)		
	42	
Mandalay (Jct. III)	—	430 miles total, I

Route II Rangoon–Mandalay (west)

		Miles	
Rangoon			
	Route I	(21)	
Taukkyan			
		57	
Tharrawaddy			
		64	
Paungde			
		34	
Prome			
		44	
Allanmyo			
		55	
Taungdwingyi			
		50	
Magwe			
		66	
Kyaukpadaung			
		57	
Myingyan			
		58	
Ye-Wun (Jct. I)		—	485 miles total, II

Route III		*Miles*	
Mandalay (Jct. I)			
		41	
Maymyo			
		84	
Hsipaw			
		44	
Lashio			
		32	
Hsenwi			
		81	
Muse			
	Route VI	(17)	
Yunnan Border		—	282 miles total, III

Route IV	*Miles*
Meiktila (Jct. I)	
	14
Thazi	
	59
Kalaw	
	44
Taunggyi	
	12
Ho-Pong (Jct. V)	
	46
Loilem	
	86
Kunghing (Nam-Pang River)	
	29
Takaw (Salween River)	
	113
Keng-Tung	
	100
Indo-China Border (Haung-Luk)	— 503 miles total, IV

Route V	*Miles*
Toungoo (Jct. I)	
	124
Bawlake	
	48
Loikaw	
	84
Ho-Pong (Jct. IV)	— 256 miles total, V

Route VI	*Miles*
Yunnan Border	
	17
Muse (Jct. III)	
	91
Bhamo	
	107
Myitkyina	
	52
Mogaung	
	230
Assam Border (Pangsau Pass)	— 497 miles total, VI

Route VII	*Miles*
Mandalay (Jct. I)	
	14
Sagaing	
	56
Shwebo	
	28
Ye-U	
	103
Kalewa	
	97
Assam Border (Tamu)	— 298 miles total, VII

Route VIII	*Miles*
Pegu	
Route I	(10)
Payagyi	
	10·5
Waw	
	16
Sittang	
	0·5
River Crossing	
	1·5
Mokpalin	
	32·5
Bilin	
	63
Martaban (Salween River)	
	3
Moulmein	
	98
Ye	
	100
Tavoy	
	155
Mergui	— 480 miles total, VIII

SUMMARY, NATIONAL SYSTEM

Route I	430 miles
II	485
III	282
IV	503
V	256
VI	497
VII	298
VIII	480
Total Length	3,231 miles

3. IMPORTANCE OF ROUTES I AND II

a. To Population

Based on 1941 population figures, there are 16 districts in Burma each of which has a population in excess of 500,000. Of these, three are in the Irrawaddy delta, and it is therefore impossible to consider them as being directly served by through primary highways. Of the remaining 13 districts, four are tributary to Route I and six are tributary to Route II.

Route I of the primary system, extending from Rangoon to Mandalay via Pegu and Toungoo, is 430 miles in length and serves (either directly or secondarily) a population of 4,300,000. Of this number, 1,150,000 are classed as urban, i.e., live in communities of greater than 1,000. This highway artery thus serves almost one fourth of the whole nation, and almost 40% of the entire urban population. Also, it connects a total of six district capitals (Pegu, Toungoo, Yamethin, Meiktila, Kyaukse and Mandalay) to the nation's capital, Rangoon.

Similarly, Route II of the primary system is 485 miles in length, and extends from Rangoon to Mandalay, by way of Prome and Magwe. The route serves a total population of 6,300,000 people, of whom almost 1,300,000 are urban residents. A third of the entire nation is thus tributary to Route II, as is almost 45% of the urban population. The highway directly connects seven of the district capitals (Insein, Tharrawaddy, Prome, Thayetmyo, Magwe, Myingyan and Mandalay) and three others are indirectly linked by means of the route.

b. To the Agricultural Economy

Likewise, Routes I and II are located to pass through the finest and most productive cultivated areas of Burma. The total land area of Burma is 170·4 million acres. Of this, 75·9 million acres are unsuited to agriculture (the land not being cultivated or less than 1% cultivated), leaving a total area available for agriculture of 94·5 million acres. Based on 1952 figures (Saunders, *Economic Classification of Land in Burma*) a total of 17·2 million acres is sown to crops. On this basis, 18·2% of the total land in Burma which is suitable for cultivation is now being sown. There are 14 districts in which this usage factor (ratio of sown land to cultivable land) is greater than 50%. Of these, four are in the delta area of the Irrawaddy, where a primary highway system is not feasible, and the Sagaing District is tributary to Route VII.

The next nine districts, in decreasing order of use, are as follows:

District	*Usage Factor (per cent)*	*Tributary to*
Insein	48·3	Route II
Myingyan	45·1	Route II
Henzada	40·5	Route II
Pegu	39·8	Route I
Tharrawaddy	36·7	Route II
Bassein	36·1	None, delta
Meiktila	33·0	Route I
Magwe	26·9	Route II
Kyaukse	26·3	Route I

The two main primary highways, Routes I and II, serve all but one of these districts, and are thus of major transport influence upon the agricultural life of the Union and therefore upon its economy.

Of the 94·5 million acres of cultivable land in Burma, 21 million acres, or 22% of the total, lie in districts either on or tributary to Route II. Likewise, the artery serves 5·2 million acres of sown land, 30% of the nation's total. Route I is also of major importance, since it serves 13 million acres of cultivable land (almost 14% of the total), and gives access to 3 million acres of sown land, or 17% of the nation's total.

4. CONDITION

a. General

As a whole, the system of national roads in Burma is in an unsatisfactory state at present. The system suffered very severe deterioration during and after World War II. Many segments of each of the main routes were battered by air attack by enemy and ally alike, as the fortunes of war shifted, and almost the entire system was subjected to incessant pounding as heavy military vehicles passed over it again and again during the hostilities. The prewar routes were generally designed and built for light traffic of moderate densities, and the use of overloaded, high-speed trucks, weapons carriers, command cars, artillery carriages, and even tanks, took a toll from which only a very extensive repair and rehabilitation program carried out in all parts of Burma can bring recovery.

Since 1951, the year in which the civil strife subsided to a large degree, except in certain small disconnected areas, it has been possible to begin the long task of rehabilitation. However, extensive work could not be done without incorporating the necessary betterments. This was not done, except in a limited way. The result is that as yet (1953), no really substantial progress has been made toward reconstruction.

Limited budgets for the construction and maintenance of the highway network of Burma appear to have been the rule, rather than the exception, during the last years. This lack of funds has hampered, if not nearly prevented, any important and extensive relocations, and the budgetary allowance made for maintenance is completely inadequate for the task at hand.

The use of hand methods for road construction and repair, or the very meager use of modern road machinery and equipment, has also hindered the carrying out of any rehabilitation program, in that the total output of the labor force with hand methods is so small as to make the costs of the work undertaken very high, and this still further restricts the whole program. The costs of work done in this period, too, were driven upward by the very high cost of road materials of various kinds.

A large proportion of the secondary system is at present only suitable for travel in the dry season. As recommended later in this Report, the basic objective in the rehabilitation of the District road system is to raise the quality of the system to the "all weather" condition.

As to the farm-to-market roads, the tertiary system is now in a very low state of development. Almost all roads are unusable in the monsoon season and the stream crossings are generally only fords. The roadways are very narrow, and in most instances are only cart tracks. A very important part of the entire rehabilitation program is the improvement of these roads and tracks to furnish the rural residents of the country the opportunity to reach an all-weather road and thus to be able to go to, and to trade in, other communities than their own.

The urban portions of the national and district systems also suffered the same sort of destruction from the war and the civil unrest as did the rural roads. Since the war the number of vehicles in use has increased markedly. The high proportion of trucks registered and using the highways and the size and weight of these vehicles are such in some cases as to tend to destroy the pavement, especially in those cases where local drainage is poor and the subgrade is thus softened.

The general lack of maintenance seems also to have plagued the city and town streets, with the result that some of the most deteriorated portions of the through routes are within cities, and also upon parallel streets which share the traffic. Later in this section will be found a description of the conditions existing at one of the major intersections in Rangoon, as an indication of the type and degree of deterioration, disrepair and hindrances to traffic flow that can occur and develop unless maintenance is adequate and enforcement of traffic and police regulations is continuous.

b. Roadway Condition

During the analysis of the road system to establish the basis for the rehabilitation program, field trips and studies were made of the pavement widths and surfaces of the highways, and of the present condition of the shoulders and other features. The conditions observed are tabulated for each of the numbered Union routes, and certain secondary routes, with supplemental comments. The field trips were made in 1952 and early 1953.

ROAD CONDITIONS

	Route	*Pavement Width (ft.)*	*Surface and Condition*	*Shoulders*
I	Minimum	10·5	Much raveling in lower section.	Narrow, generally depressed from roadway, difference being 3–4 inches in most cases. Most shoulders rough, need blade work and other maintenance.
	generally	12		
	Meiktila–Mandalay section generally	12–14	Upper section, rough, some raveling.	
	with 5 mi.	16–18		
II	First 32 mi.	14–18	Raveled edges.	Shoulders narrow, 3–6 inches below pavement edge.
	Next 10 mi.	12–14		
	Next 15 mi.	8–10	Considerable raveling.	
	Next 17 mi.	8		
	Next 11 mi.	9		
	Next 57 mi.	10	Surface fair, edges repaired.	
	Next 35 mi.	9–10		Condition poor, much maintenance needed in some sections.
	with 1 mi.	16		
	177 mi. to Prome			
III	*Mandalay–Maymyo*			
	First 3 mi.	12	Bituminous treated, bad raveling.	Grade up shoulders.
	Next 14 mi.	14–16	Bituminous treated, bad raveling.	Shoulders 2–2½ inches low.
	Next 25 mi.	12–14	Bituminous treated, bad raveling.	
	42 mi. to Maymyo			

ROAD CONDITIONS—(*continued*)

Route		*Pavement Width (ft.)*	*Surface and Condition*	*Shoulders*
III *Maymyo–Lashio*				
First	3 mi.	12	Bituminous treated, rough, bad raveling.	1–3 inches low.
Next	10 mi.	12–14	Edges fair, not too much raveling.	
Next	25 mi.		Badly raveled.	
Next	11 mi.	10–12	Badly raveled.	Narrow, especially at switchbacks.
Next	18 mi.	10–12	8 mi. good condition, 10 mi. under construction.	Shoulders satisfactory.
Next	15 mi.	11	Bituminous treated, very bumpy and rough.	Poor.
Next	14 mi.	10	Wavy, rough.	Narrow, rough
Next	21 mi.	12	Regrade bad portions.	
Next	18 mi.	10	Wavy and bumpy.	
	135 mi. to Lashio			
III *Lashio–Hsenwi*				
First	8 mi.	10	Bituminous surface, fair shape but needs some cold patching.	
Next	24 mi.	10	Fair condition, had heavy traffic during war, no foundation failures.	Some shoulders too low.
	32 mi. to Hsenwi			
Secondary Route to III *Lashio to Laihka*				
First	7 mi. on Route III			
Next	18 mi.	12	Two 3-ft. tracks, has high maintenance cost, in rough condition.	Shoulders below pavement
Next	20 mi.	10–12	Traffic-bound macadam, rough and needs blading and shaping. Some foundation failures.	Need patrol grader work.
Next	122 mi.	10–11	All traffic-bound macadam. Rough, many potholes, much maintenance needed. Some raveling, and much raveling in about 20 miles of length.	Shaping and raising of shoulders needed. Patrol grading, on a regular basis, is best maintenance.
	167 mi. to Laihka			
Secondary Route to III *Laihka to Lashio via Mongnaung*				
First	27 mi.	10	Traffic-bound macadam, crown needs reshaping, rough to very rough in some spots.	Build up shoulders, which are very low.
Next	49 mi.	10	2 mi. with Telford base, all traffic-bound surface, rough to very rough, much blade work needed.	Raise and reshape shoulders most of length.
	76 mi. to Kehsi			

ROAD CONDITIONS—(*continued*)

Route	*Pavement Width (ft.)*	*Surface and Condition*	*Shoulders*
IV *Taunggyi–Thazi*			
First 15 mi.	16	Bituminous surfaced, raveled edges, needs major maintenance.	
Next 29 mi.	12	Raveled edges, potholes.	Rough.
Next 60 mi.	11	Badly in need of maintenance and repair, and more bituminous material is needed.	
104 mi. to Thazi			
IV *Taunggyi–Loilem*			
53 mi.	Average 12	Bituminous surfaced, raveled, large potholes, needs surface repair.	Raise shoulders to proper grade.
Secondary Route to IV *Loilem to Laihka*			
33 mi.	11	Half bituminous surface, half macadam, rough and badly in need of repair and treatment.	Shoulders are low for entire length, need to be built up.
V *Hopong toward Namhkok*			
9 mi.	10	Macadam, short sections of bituminous treated, needs treatment and much repair.	Regrade shoulders.
VII *Mandalay–Shwebo*			
First 3 mi.	16	Bituminous surfaced, some raveling.	Shoulders low, need raising and shaping.
Next 9 mi.	12	Bituminous-treated gravel, raveling.	Raise low shoulders.
Next 19 mi.	10	Macadam and bituminous.	1 mile cobbled shoulders, poor condition. Other shoulders satisfactory.
Next 9 mi.	12	Bituminous treated, 6 inches gravel surface, foundation failures.	
Next 9 mi.	12	Gravel surface, poor condition and numerous foundation failures.	
Next 1 mi.	12	Macadam, very rough.	
Next 5 mi.	12	Gravel surface, well maintained.	
Next 15 mi.		Surface in good condition.	Shoulders need reshaping and some regrading.
70 mi. to Shwebo			

(1) Other Data on Road Condition

(a) Route I. While the pavement is much reduced by raveling there is believed to be sufficient foundation material to have an 18-ft. width on the mileage to Pegu. No evidence of foundation failure.

(b) Route II. Mile 32–42 (measured from Rangoon) has embankment, the maximum possible surface width is 16 ft. Trees up to three feet in diameter are on several long embankments, and their roots are breaking the pavement surface.

(c) Route III. The alignment and grades upon two segments of the route are very severe, and nearly impossible for truck traffic, and the route should be relocated between Mile 16·2 and Mile 31 (measured from Mandalay) and from Mile 80 to Mile 92 (which includes many switchbacks where the pavement is dangerously and inconveniently narrow).

The 24 miles of Route III south of Hsenwi were built in 1939, consist of 4½ in. soling stone, 4½ in. of macadam, and bituminous-treated surface. First mile south of Hsenwi subject to floods and should be raised at least three feet, resurfaced.

(2) General Comments

During the field inspection trips, numerous examples of the inadequacies of the maintenance program and of the costliness of hand labor methods were observed. During the inspection of the secondary highways of the Laihka–Mongnaung area, 167 miles of road were covered. In this distance, the total road gangs consisted of 33 coolies, working entirely by hand methods and without tools.

On Route III east of Maymyo, water was being applied to macadam construction by driving the water tank over the roadway surface, dipping water out of the tank and applying it to the roadway in buckets. Instead, two pieces of pipe, a valve and one hour's welding would have mechanized the whole operation.

As illustrative examples of the present condition upon the national system of highways, and to an even greater extent upon the district and other secondary roads, see Plate 1. These illustrations demonstrate graphically the worsening of the condition of the pavement when the shoulders are not properly maintained, and when surface water is not disposed of. In the three illustrations, which are representative of the conditions encountered on Route I, the shoulders have been neglected and permitted to recede from the pavement edges, and are now four to six inches below the latter. This is the basic cause of the raveling, and must be repaired as a first order of business in the rehabilitation program. Note also in the notes with the pictures, that the net width of pavement is materially reduced by the raveling. This forces still more vehicles to leave the pavement, and this act produces still more raveling and narrowing.

The entire story of the present condition and state of repair of the highway system of Burma can be seen in outline from the comments offered above as to roadway condition and width, foundation condition, and general lack of adequate and safe shoulders. The latter condition especially is almost completely a maintenance problem.

The general concept of adequate and proper maintenance must be raised. If it is not, there is no point in rehabilitating the highways, for they will fall into disrepair as fast as they are reconstructed. As recommended later in the Report, the general use of machine methods for both heavy construction and maintenance is mandatory if this problem is to be solved within the money and labor limitations of the Union.

c. Location, Alignment, Existing Geometrics

The field trips indicated the need for an intensive study of the geometrics, alignment, and general location concept of all parts of the system, especially the Union network. This study was made, and the results and corrective measures to be taken are included in the recommendations of the Report.

Basically, the faults in alignment, geometrics and general design were found to be:

(1) That many of the curves and sharp bends on the routes were too abrupt for either the present vehicle speeds or the increased speeds to be expected with the rehabilitation and improvement of the system.

(2) That the grades, in some cases, were too steep for truck and bus operation at reasonable speeds.

(3) That there are a number of instances, especially on Routes I and II, where long embankments have their grade lines low enough to be subject to flooding. These should be raised.

(4) That there are a great many railroad-highway grade crossings which could easily be eliminated. For example, between Pegu and Meiktila, Route I crosses and recrosses the Burma Railways line a total of 21 times, or an average of one crossing per 13·5 miles. Such crossings are a source of constant expense for maintenance, and of danger under busy rail or motor traffic. Present traffic is not such as to make these highway relocations vitally necessary now, but the long-range program should include the design and scheduling of these projects in an orderly and planned manner. The earlier the land acquisition, the less expensive will be its cost.

(5) That the routings of the highways through local communities are, in some cases, needlessly tortuous.

A. Opposite B.A.F. Base near Mingaladon.

Shoulder 6-6½" below adjacent pavement.

Net pavement width 10'-7"

NOTE:- Standing 12" ruler, foundation course.

B. At Mile 13

Shoulder 4" below pavement

NOTE:- Water filled chuckholes, vehicle tracks off of pavement, old foundation course.

C. At Mile 16, opposite Hlegu Rubber Estate.

Shoulder 6" below pavement.
Net pavement width 11'-1"

NOTE:- Ruler, standing water.

PLATE I

CONDITION OF PAVEMENT
PROME ROAD (Route II)

In most instances the condition can be corrected, and the cost of the betterment will not be great.

(6) That in some portions of the routes, there appear to be an excessive number of small drainage structures. The more important ones must be maintained in effective service, and it would be preferable to enforce this concept, rather than dissipate the maintenance funds and efforts on the whole group. Recommendations for the correction of these faults, and others which are not so numerous, are included in Section Q.

d. Drainage

Drainage, the process of removing surface and subsurface water from the roadway, or preventing such waters from reaching it, is of supreme importance in the maintenance of a highway. All soils become soft when wet, and they are then unsuitable as a road surface or subgrade. Further, excess water standing on the surface of a highway and the adjacent shoulders interferes with the safe and proper flow of traffic. It should be promptly removed or prevented from gathering.

In the rural portions of the highway system of Burma, drainage is effected generally by means of open ditches. These must be maintained to permit free flow of drainage water at all times. Neglect of this, the most important feature of road maintenance, results in the failure of the foundation, and of the surface course as well.

There are indications of the lack of adequate drainage maintenance on many miles of the highway network. This neglect is due to several causes, but the prime factor is the widespread reliance upon the formula that a proper job can be done with "one coolie per mile" of highway. This degree of maintenance is completely inadequate, even for the least traveled and least important roads in Burma. Instead, as is discussed in Section I, and subsequently recommended in the Report, an adequate program of maintenance with modern highway machinery, such as is used in many countries, should be instituted at once.

Mechanized maintenance operations have been adopted, on a limited basis, in several of the States in Burma. In the Shan States, for example, the use of modern procedures and techniques began as an economy measure. However, the existing equipment is World War material now seven to eight years of age, and the shop repair costs are steadily increasing. Also, the securing of repair parts is very difficult at present because of exchange difficulties.

To indicate the degree to which poor maintenance exists, and is causing foundation and surface failure in all parts of the system, the following abstracts from the detailed reports on highway condition will establish the common pattern:

Route I

Mandalay to Meiktila—clean out ditches, re-establish ditch lines.

Meiktila to Yamethin—foundation failures in numerous places, due to poor drainage.

Route III

Mandalay to Maymyo—reditching needed for 25 miles west of Maymyo.

Maymyo to Lashio—foundation failure due to faulty and inadequate drainage (Miles 13–38, 49–56, 61–65, 82–96). The side slopes in cuts should be flattened, to avoid local slides which fill up the ditches.

Lashio to Hsenwi—ditches should be cleaned out, and in some cases enlarged to permit adequate flow.

Route IV

Taunggyi to Kalaw—a major maintenance operation is called for, and the ditches must be cleaned out and resloped.

Taunggyi to Loilem—ditches must be opened up, and the pipe cross drains are blocked in many places.

General reditching is necessary over the whole route.

Route V

Southward from Ho-Pong toward Loikaw—Maintenance of both the shoulders and ditches is badly needed.

Route VII

Sagaing to Shwebo—Ditches need cleaning out, and resloping back slopes. Ditches on several portions should be enlarged, to furnish adequate drainage. Numerous foundation failures because of inadequate drains, poor underdrainage. Replace the ford at Mile 26 (from Sagaing), to avoid delay at time of flood.

As to secondary roads, the comments and observations in the field notes on the routes between Lashio and Laikha are much the same, as indicated below:

Lashio to Laikha, via Hsipaw—ditches are filled and not in service; ditches, shoulders and back slopes need attention; foundation failures due to poor drainage, ditches need cleaning, resloping and sloping; ditches are filled and not functioning; ditches are partly filled and need cleaning out.

Lashio to Laikha, via Mongnaung—ditches are partly filled, inadequate, need to be cleaned out and resloped: Miles 19–23, 23–27 (cut side banks back), 29–46 and 65–67, where a major operation is needed on the ditches.

These indications of the existing drainage conditions parallel those which have been permitted to develop for the roadway surfaces and shoulders. Lack of adequate maintenance is the prime cause of the deterioration. If the rehabilitation of the highway system is to be effective, it must be preceded and accompanied by adequate maintenance, and this should be carried out by modern road machinery and equipment.

e. Structures

In general, the structures on the union highway system were found to be in fair condition, although a great many are in need of maintenance, and a few need reconstruction or replacement. However, nearly all of them have a very serious drawback, in that they were generally designed for very light loads as compared to the heavy trucks now using them.

There are some important gaps, especially in the primary system, some of which seriously impede the major traffic flow movements, and lessen the utility of the entire network. Some of these are of many years' standing, and result from topographic features and watercourses. These are discussed in the next subsection of the Report. Others have resulted from the destruction of war, and the succeeding period of civil unrest. Still other structures have been damaged, or have failed, as a result of overloading. This overloading first occurred during the war years, but the shortage of vehicles and lack of adequate truck transport that have existed since the cessation of hostilities have continued and even accelerated the overloading of heavy vehicles. Other structures, especially those entirely of concrete, have suffered deterioration from lack of maintenance and need repair and strengthening. These effects and conditions, as observed and recorded during the inspection trips, are tabulated below.

One noticeable fact with regard to the existing structures is that they include a very high proportion of Bailey bridges. These were placed in service during the war, and in some cases have been used, from surplus military stocks, as replacements for structures destroyed during insurgent activity. While the load limits of the original design were very well established, conditions and needs have caused these structures to be installed in sites where the span was too great for the loads using the highway. As a result, overloading has occurred and the stability and safety of the structure have been seriously impaired. In general, the sagging of the floor and excessive truss deflections are the best indications of overload and distress.

For highway loadings the Bailey bridge design, as adapted to civilian use, has the following safe load limitations, for the several spans and arrangements:

Single truss, single story

Span	*40*	*60*	*80*	*100*
Safe Load,* tons	32	26	18	10

Double truss, single story

Span	*60*	*80*	*100*	*120*
Safe Load,* tons	67	51	31	18

Double truss, double story

Span	*100*	*120*	*140*	*160*
Safe Load,* tons	75	50	31	19

* Safe load can be placed anywhere on the deck; the vehicle speed should not exceed 25 miles per hour; there should be no sudden stopping or accelerating; and the vehicles should be spaced at least 100 feet apart.

On this basis, it does not appear that the bridges that have suffered distress from overload did so from a single heavy vehicle, unless this happened during the hostilities, where there were occasional military vehicles which could have been at fault. The distress was probably caused by the passage of vehicles traveling rapidly, or too close together.

The most obvious shortcoming of the Bailey bridge in civilian use is that the effective roadway, between inner faces of curbs, is only 12 ft. 6 in. This width is not sufficient for the passage of two vehicles, so that delay results to the one which must wait for the passage of the oncoming vehicle. In other countries where Bailey bridges have been erected on primary highways, the usage is generally only temporary to meet an emergency condition. It is suggested that the Bailey structures in use on the primary highways, especially those on Routes I and II, be dismantled and re-erected upon the district and less important roads, where the traffic demands are less severe. As noted below, first priority should be given to those structures on which the overloading has been severe enough to produce distress.

Current practice in countries where the density of vehicle traffic is constantly increasing, resulting in ever widening roadways as a remedial measure, is toward the general use of deck structures, rather than pony trusses and short span through-trusses. With the use of either of the latter two, the roadway width is fixed and cannot ever be increased. The deck structure, which in general has its most economical use for beam spans up to about 90 ft. in length, and more for trusses, can have its framing and slab details so arranged as to permit removal of either or both curbs, and the convenient widening of the roadway. The deck structure is also generally safer, as there is greater visibility and no possibility of structural damage to the main load-carrying members.

It is also recommended that all present timber decks be replaced with concrete slabs. The maintenance costs of the former are very high, and the structures require almost constant attention, tightening, and replacement of defective planks, railing and similar features.

The list of structures found to be in unsatisfactory or unsafe condition is given below, as an abstract of the notes made during the inspection trips. In general, the grouping is by routes, extending from Rangoon or from the origin of the route. See Plate A for the general locations. The route mileages, between important points, are as shown earlier in this section. Based on the condition surveys, proposals as to repair, reconstruction and replacement are included in the detailed recommendations of the Report. The major structures are treated separately.

Route I (Rangoon–Mandalay, east).

Mile 26—Ngamoyeik River, two pony trusses in bad repair.

Mile 36—Double Bailey bridge, which should be replaced to permit two-way traffic.

North of Pyawbwe—Two small unbridged chaungs, some flooding and delay at certain times of year.

Mile 329 (8 mi. south of Meiktila)—Three 100-ft. pony trusses over Chaungga River are out, need replacement.

Mile 331—Single Bailey bridge, in only fair condition.

The Bailey bridges on the Meiktila–Mandalay section are in fair, or nearly fair, condition.

Mile 379·5—100-ft. Bailey span, floor sags from overloading.

Route II (Rangoon–Mandalay, west). Floors on a number of bridges have had to be replaced as a result of destruction by insurgents, and the structures are in fairly good repair. The longer structures consist of pony trusses or Bailey bridges, and a number of the latter have been overloaded, as indicated by deflection in both the floor and trusses.

Mile 262, 9 mi. north of Nyaungbintha—small unbridged chaung, some delay when flooded.

Mile 310·5, 14·5 mi. south of Magwe—Yin Chaung, east of Thayetlebin, with ford or ferry crossing. Bridge should be constructed (700-ft. span), unless route is relocated.

Mile 339, 14 mi. north of Magwe—Khodaung Chaung, often in flood after heavy rainfall, should be bridged if Route II is not to be relocated.

A general relocation of Route II between Taungdwingyi and Kyaukpadaung to bypass both Magwe and Yenangyaung is recommended. See Section Q, and Plate 13.

On the Kyaukpadaung–Meiktila Road, there are nine unbridged chaungs, which may be flooded a number of times each rainy season, causing delay to traffic. The crossing at Mile 14, known as the "Water Hole Chaung" should be improved, especially as to alignment.

On the Taungtha–Meiktila Road, the Thinbon Chaung is crossed at Mile 33, and several hours' delay for traffic often results from a heavy rain.

The last remaining timber bridge on Route II between Taungtha and Myingyan, should be replaced.

A relocation of Route II from Taungtha to Mandalay, to by-pass Myingyan and take advantage of the abandoned railway grade from Natogyi to Ava is proposed in Section Q. For the location, see Plate 14.

Route III (Mandalay–Lashio–Yunnan).

Mile 15—The Bailey bridge shows considerable sagging, from overloading, but its condition otherwise is good.

Other structures between Mandalay and Maymyo are in good condition.

Mile 16·2 to Mile 31—A general relocation to avoid the hairpin turns, switchbacks and steep grades which now confront the traffic using the present road, is recommended in Section Q, below. The proposed location is shown on Plate 15.

Mile 52—The reinforced-concrete bridge (four 50-ft. spans) at this location shows considerable cracking and spalling of the rails and along the curbs, and the superstructure should be reinforced and repaired.

Mile 80 to Mile 92—A general relocation is proposed for this portion of Route III, to avoid the great number of switchbacks and severe grades (up to 15%) existing on the present location. Improvement of these conditions is needed to permit the use of the road by developing heavy common carrier or private trucking. See Section Q for recommendations.

Mile 84—100-ft. deck truss and two 30-ft. concrete approach slabs, in good condition at present.

Mile 150—120-ft. and 40-ft. Bailey spans, with one concrete flanking span, only in fair condition.

Mile 180, 4·5 miles north of Lashio—125-ft. Bailey bridge, with excessive sag in floor, but otherwise in fair shape.

Mile 206, 1 mile south of Hsenwi—125-ft. Bailey span, with two 30-ft. approaches, noticeable sag but floor in fair shape.

Mile 3·5, east of Hsenwi on Kunlong Road—50-ft. Bailey span, with considerable sag but floor otherwise in good condition.

Lashio–Laikha Road (via Mong Yai). Mileages are measured from Lashio, including seven miles along Route III.

Mile 24—50-ft. and 150-ft. Bailey spans, the latter with excessive permanent deflection. Timber floor of both spans loose and in bad shape. Approach roadway section too low—needs 1½ mile regrading to eliminate flooding.

Miles 30, 49, 51, 57—Pony truss spans, in good or fair condition. At Mile 54, 40-ft. Bailey span in good condition.

Mile 61·3—30-ft. I-beam span, plank floor loose and in bad shape.

Mile 77·5 (Boundary, NSS)—100-ft. pony truss with sag due to overload, but flooring is in good condition.

Mile 98·5—80-ft. pony truss in fair condition.

Mile 112—50-ft. I-beam span, with loose wooden floor in poor condition.

Miles 119·5 and 128·5—I-beam span and triple-span concrete-slab bridge, in fair and good condition, respectively.

Mile 137—I-beam bridge, three spans of 30 ft. badly in need of repair.

Miles 140 and 161—Three 25-ft. and two 30-ft. concrete-slab spans, with very badly spalled concrete; rails are partially gone and general condition is bad.

Laikha-Lashio Road (District road, via Mongnaung and Man Sam).

Mile 2·5—30-ft. I-beam span, with plank floor and railings in bad condition.

Mile 3—Trestle bent wooden structure, with two 40-ft. and five 30-ft. spans. Built by Japanese during war, has a load capacity of less than four tons.

Miles 15 and 55—I-beam bridges in good condition.

Route IV (Meiktila–Taunggyi–Loilem–Takaw).

Mile 3—I-beam bridge, 30-ft. span, and
Mile 115—60-ft. Bailey bridge, both in fair condition.

From Thazi (Mile 14) to Kalaw (Mile 74)—no bridges in excess of 100-ft. span; all structures are either Bailey or pony trusses.

Route V (Toungoo–Ho Pong).

Mile 24, at Paletwa—Bailey bridge over Thaukyequat Chaung.

Mile 108, 16 miles south of Bawlake at the crossing of the Htu Chaung, there is a flying ferry, and one half hour is taken up in the operation.

Route VI (Assam–Yunnan, via Myitkyina and Bhamo). There are many fords on the route, and a number of these cause so much delay during the flood season that they should be studied for possible replacement.

Ledo–Myitkyina section is motorable only during dry weather.

Mile 88 (from Bhamo), at Kazu—Crossing of Nam Chaung by flying ferry.

Mile 95, Ferry over Irrawaddy, at Waingmaw–Kacchaw, and route goes on into Myitkyina, Mile 107. This ferry will, with developing traffic, become a bottleneck on the route and should be planned for replacement by a structure.

Route VII (Mandalay–Tamu, via Shwebo and Kalewa).

Mile 40—Concrete-paved ford, which cannot be crossed during flood, should be replaced.

Mile 14–Mile 56.—Between Sagaing and Shwebo, there are only minor structures, either Bailey bridges (3) or plate girder spans (3) and all are in good state of repair.

Mile 95—At Ye-U on the Kin U–Ye U road, the Mu River is crossed by a temporary bamboo bridge during dry season, and a ferry during wet season. With increasing traffic along this route this condition will have to be eliminated by the construction of a permanent structure.

Mile 115–Mile 148, between Kaduma and Pyingaing—Numerous unbridged chaungs result in delay to traffic during rains.

Mile 148—Pyingaing to Pyinsama—four unbridged chaungs, with very tortuous and steep approaches over pierced-metal matting.

Pyinsama to Shwegyin—Chaungs now all bridged and structures are in good condition.

Mile 192—Shwegyin to Kalewa. Six-mile toll ferry and approaches, the west of which is steep and in poor condition. Fees are:

3-ton trucks	K37.50
¾-ton trucks	K25.00
Cars and jeeps	K12.50

Shwebo–Kyaukmyaung Road.

Mile 14 and Mile 16—very narrow and dangerous bridges.

Kyaukmyaung to Thabeitkyin—Ferry crossing of Irrawaddy River.

Route VIII (Rangoon–Mergui, via Payagyi). On the basis of the anticipated rate of growth of vehicular traffic in Burma, and especially the Tenasserim, it does not appear that the water gaps along this route will need to be bridged for some time to come. The location and size of the streams entering the Andaman Sea from the peninsula, roughly normal to the general direction of Route VIII, are such as would make the cost of a through primary facility very expensive. Instead, this highway should be developed at present on a local service basis, to bring the smaller towns and villages within the convenient range of Moulmein, Tavoy and Mergui. Then, as traffic developed, the water gaps could be closed, the ferries eliminated one by one, and the continuous highway would grow in length and usefulness as the developing needs required.

The planning, on a long-range basis, should be for the maximum social benefit for the entire community, as balanced against the several major incremental costs.

The first stage in the process has begun, in that a decision was finally taken, late in 1952, to proceed with the design of the new Sittang River bridge as a combined railway-highway bridge. The delay of nearly six years in reaching the decision was unfortunate as the whole transport system will suffer until the gap is closed.

Early steps should be taken to study the relative need for the completion of the highway bridge at Waw, to complete the upper end of the route, as compared to the construction of a "down country" stream crossing to improve the local highway utilization below Moulmein. In the solution of this problem, as in all of the other similar choices, one of the factors to be considered is the relative degree of service offered, in over-all transport, by the Railways.

These larger water gaps in the route are listed in detail in the following subsection. Other comments as to condition of structures, as revealed during the field inspections, follow. Mileages are measured from Payagyi, the start of Route VIII.

> Mile 11, Waw—Bailey bridge over Pegu–Sittang Canal, in only fair condition, and the approach grades and alignment are not good. At present vehicles proceeding west of Waw during the rainy season must be shipped from Pegu to Sittang.
>
> The Railways operate a ferry across the Sittang River, and there is also a PWD ferry at this location.
>
> Mile 168–Mile 225, Thanbyuzayat to Ye—Following the destruction of the permanent structures early in the war, temporary and very weak bridges were crudely constructed by Japanese labor. The present program of replacement by permanent structures should be completed.

f. Urban Conditions

The detailed inspections of the conditions of highways through cities and towns to establish the shortcomings which should be recognized in formulating the recommended rehabilitation program, were encouraging in that they revealed no basic faults other than actual damage which had not been repaired. They were discouraging, however, in that in almost all cases adequate maintenance was lacking on the local street and road systems. Also, as noted earlier, many of the faults which impeded traffic were those which would not have existed with complete enforcement of regulatory legislation by the police and other city authorities.

As an example, Plate B shows the traffic and physical conditions at one of the busiest intersections in Rangoon. The summary is a literal copy of the comments made by the observer, in July 1953, with explanatory diagram. The faults found and the impediments to traffic are those which occur repeatedly on the streets of almost all of the cities and towns.

The basic objectives of the local improvement program, recommended in the Report, are to correct such conditions as those shown; to repair and repave all rough and deteriorated pavements; to properly grade and pave the entrances on the main streets from less important side streets; to eliminate all sidewalk stalls and other unnecessary infringements on the traveled roadway; to prevent the use of street areas for open garages, timber merchants and other workshop activities. Generally, except in a few streets and at several intersections, the pavement condition appears to be good, except immediately adjacent to curbs. Often, with the flat grades that generally exist along the city streets, water stands in these "edge" areas. Drainage, too, needs to be improved, and specific suggestions and recommendations are made later in the Report.

Many, if not all, of the impediments and obstacles to the flow of traffic in busy urban areas can be eliminated by a formal determination of the policies to be followed in street access and parking matters, continuing local police enforcement of these policies, and an alert and high degree of maintenance of all features, especially drainage.

g. Needs

To summarize the findings as to condition of the present highway system of Burma, and to draw short conclusions as to the indicated needs, the following points are made.

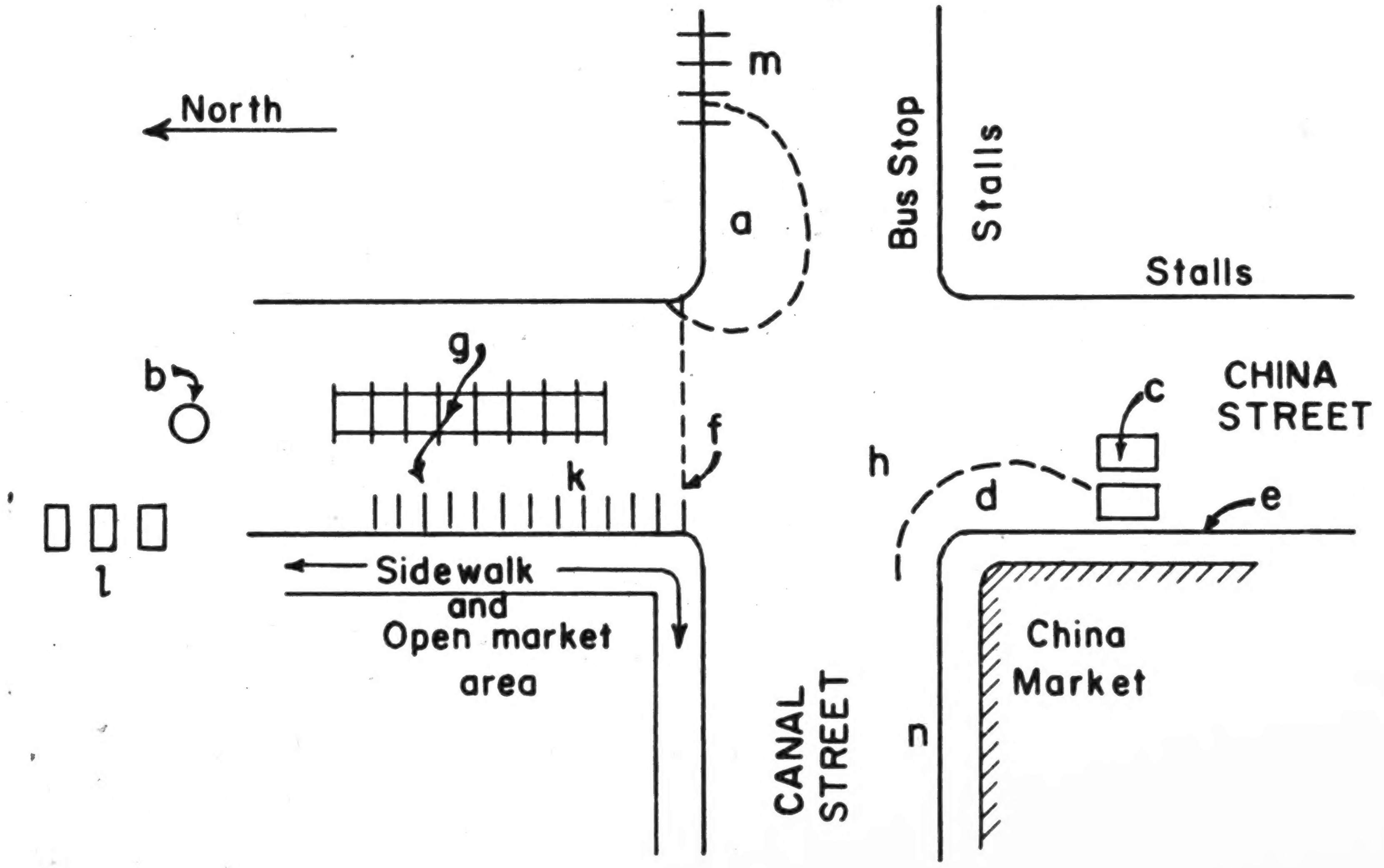
(1) The system of national and district highways in Burma is at present not in satisfactory condition, measured by modern standards. The causes are the destruction during war, the further deterioration during the insurgency years, the lack of funds and of adequate planning for the rehabilitation programs. More detrimental to the physical condition of the roads is

(2) The continued use of hand methods for both highway construction and maintenance in almost all parts of the Union. Very little modern road-building machinery is in use, and that is of such age that the maintenance of the units has become both expensive and troublesome.

(3) The lack, for example, of the use of patrol graders or other similar maintenance equipment has brought about the gradual lowering of the shoulders and the deterioration of their surfaces, and the result has been to cause the raveling of the edges of the existing blacktop pavements, the reduction in net

PLATE B

SUMMARY OF TRAFFIC AND PHYSICAL CONDITIONS CANAL ST. AND CHINA ST. INTERSECTION, RANGOON.



PHYSICAL CONDITIONS:-

a. 20 ft. x 50 ft. chuckhole, 6-8 inches deep, water filled.
b. Sewer manhole under head and flowing 30 - 40 gallons per minute.
c. Garbage containers on steel stands, taking up 40 % of street width.
d. Accumulation of decaying vegetable matter, 3-4 inches deep.
e. Stalls infringe 6-9 ft. on roadway widths.
f. 18-24 inch street cut, 12 inches deep, not backfilled.
g. One quarter of space between rails is gone, the chuckholes being 6-8 inches deep. 10 % of whole street area here is bumpy, and with ruts.
h. One third of the northwest quarter of intersection is rough, broken pavement.
i. The sidewalks are poor, or there are none.
j. There was some water standing in all gutters, where there were any.

TRAFFIC CONDITIONS:-

k. 12 trishaws seem to park here, partly impede south bound traffic.
l. Terminal for 6 buses, which also congests the free roadway.
m. Terminal for 4 buses.
n. East bound buses parked here, on wrong side of street.
o. Sidewalk booths interfere with traffic and slow down bus loading at several locations.

width or destruction of pavements, and the wastage of the public funds which went into the making and keeping of the system.

(4) The drainage system of the highways is badly in need of maintenance. The pavement foundations must be kept properly drained to avoid deterioration and destruction of pavement surfaces.

(5) A very general modernization of the alignment of the entire system is required. There are many sharp curves and abrupt bends which should be eased, or eliminated, in the interest of the comfort and safety of the traveling public.

(6) Relocations are also needed in a number of segments of the system, largely to reduce the ruling grades so that heavy trucks will be able to travel safely and conveniently on all parts of the national and district systems.

(7) The routing of the national highways through some cities and towns should be improved, as it is often very tortuous and time-consuming. The unnecessary mixing of local and through traffic within the communities should be eliminated to the greatest possible degree.

(8) Grade lines, in a number of instances, should be raised to prevent the flooding which now occurs.

(9) Structures in general have been overloaded, are lacking in load-carrying capacity, or are of insufficient roadway width, especially in the case of the Bailey single-lane structures. A gradual and ordered replacement of the existing structures is called for, and the Baileys that are retired from the main roads should be re-erected upon the minor roads.

(10) The Ava bridge should be again placed in service for motor-vehicle traffic, and at an early date, and the structure over the Pegu River at Pegu should be replaced.

5. COST OF INSURGENCY

Insurgency and the acts of lawless elements have been of great cost to Burma. Primarily, the effect appears to be one of physical destruction of bridges and roads. The secondary effect is the prevention of well organized maintenance operations. Nowhere is there clearer evidence that the lack of sustained maintenance is ruinous to a highway system than in Burma at present.

The 1949–50 report of the Department, issued in 1953, indicates that the following road repairs were made during the year to road surfaces and structures, largely to repair the damage and destruction by insurgent forces and other lawless groups:

Route I. 55 bridges were burned or blown up. The normal program for seal coating was abandoned during the year in order that staff could be used on the installation of the communications system for the army. 15 major and minor bridges, located between Mile 272 and Mile 381, had also suffered severe damage, but were repaired and kept open.

Route II. The road north of Letpadan (Mile 90) was liberated from the insurgents in May 1950. The surface was found to be deteriorated, the anti-government groups continued to harass the working of the local quarries, the highway maintenance continued to be shockingly inadequate, and further damage resulted.

34 bridges were repaired, but neither the extent of the damage nor the cost of the reconstruction are indicated.

Route III. One Bailey bridge (at Nadaunggya Chaung) was erected, to replace a demolished permanent bridge, and should itself be replaced as soon as possible. Two other Baileys were replaced with I-beam spans.

Route VII. On the Ye U–Tamu Road there are 795 structures. Of these, 143 Baileys were maintained properly, but many other structures could not be properly repaired.

Route VIII. At Mile 48, a deck structure was burned out twice during the year and replaced. Another structure at Mile 33 was thrice damaged. Five timber bridges were completely destroyed and were reconstructed.

The damage was great too, on the secondary roads, and this also imposed a burden and expense on the Department. Repeatedly in the report, the tragedy of this kind of destruction and its terrible total cost to the Union as a whole is conveyed by such entries as:

> "Ye U–Monywa Road (23⅜ miles). The area along the road was occupied by insurgents and most of the bridges were believed to have been destroyed and between Ye U and Tabayin trenches had been cut across the tarred portion of the road."
>
> "Monywa–Ye U Border Road. This remained in the hands of insurgents till late in April 1950 when the first ten miles could be open to traffic."
>
> "Myinmu–Monywa Road. The insurgents had destroyed almost all the bridges and traffic was on diversions and improvised bridges and causeways."

Perhaps the best statement of the performance by the Department, under these conditions, is that made with regard to Route I:

> "It was possible to keep the road just trafficable at a very low standard of maintenance."

In the 1950–51 Report of the Department, Chapter VII is titled "Destruction Caused by Insurgents." It begins as follows:

ROADS AFFECTED

"The destruction caused by the insurrection to roads was very extensive. Numerous major and minor bridges suffered destruction and in several cases repeatedly. The road surface in many districts also deteriorated extensively for want of maintenance due to the fact that some of the roads were inaccessible.

"The main districts affected were Pegu, Toungoo, Magwe, Mandalay, Meiktila, Insein, Prome, Thaton, Amherst, Tavoy, Mergui and Akyab.

"As far as it is possible to estimate, more than 150 bridges costing about Rs.11,00,000 were destroyed. The cost of repairs to some of these amounted to Rs.3,81,840 as the rest of the destroyed bridges had not as yet been reconstructed as the bridges had not been accessible, having been in insurgent areas."

Then follows a list of some 47 roads which were affected in insurrection, and some of them were very seriously damaged.

The destruction of bridges is very great, for the repair or replacement of 150 structures is in itself a major operation, one that the department would find well nigh impossible to cope with in any one year. Also, the cost of replacement is still another heavy burden to be placed on the shoulders of the whole population.

Civil strife, too, is not without human tragedy to those who must perform public work. During 1950–51, one coolie foreman was taken to a newly restored bridge near Gwegyo and murdered as "a threat against future offenders." And, in an attack on Mergui in 1951 the deputy commissioner was killed in action. During the year, also, a department transport driver was killed by an insurgent land mine and three laborers were killed in an attack on a department truck.

6. GAPS IN SYSTEM

As indicated in preceding paragraphs of this section of the Report, there are some important gaps in the continuity of the highways of Burma. The gaps discussed in detail thus far have been almost entirely those resulting from lack of structures along the main routes of the system. In many cases, bridges are simply war casualties which have not yet been replaced, or casualties of the later civil strife. In other cases, the lack is simply that the current stage of development of the system is such that the need for the particular river crossing, or other improvement, has not fully manifested itself.

In a few cases, such as those of the replacement of the demolished spans of the Ava Bridge, and of the relocation and reconstruction of the Sittang crossing, the need for the facility is so great that its building is long overdue. For these major projects, the general facts and brief background relating to each are listed below. Necessarily, the order in which these are undertaken is a problem with many facets, not the least of which is the availability of funds for the work. All of the projects are important, and in the full development of highway transport in Burma all these (and many others, as yet unknown in either nature or scope) will be undertaken. The order in which they are set down is a reflection of their urgency and of their importance to the orderly and adequate upbuilding of the highways of the Union.

(a) At Ava, 12 miles south of Mandalay, Route VII crosses the Irrawaddy River. The original structure here, a combined railway-highway bridge, was a war casualty, two 350-ft. spans having been demolished by the British during the evacuation in April 1942. The bridge is a very important link in the whole network but has not yet been put back in service. Two crude and wholly inadequate ferries are now operating between Amarapura and Sagaing, and a traffic delay of up to 25 minutes can occur under the present operation. The ferry having the larger vessels, carrying loads up to eight tons, is a toll facility and the fee for passenger cars is K10. The closing of this gap is the most vital step to be taken in the highway rehabilitation program, and should be given very high priority.

(b) At Myitnge, 12 miles south of Mandalay on Route I, a 1½-mile diversion is now in effect to replace the bridge over the Myitnge River. The diversion consists of Bailey spans, the total length being 580 ft. The original crossing was a combined railway-highway structure, and was destroyed during the war. The replacement bridge carries only the railway, and tenders are now (July 1953) being invited for the substructure and superstructure of the new highway bridge which is to have a total length of 755 ft.

(c) At Pegu, Route I crosses the Pegu River at the west edge of the city. Using parts of Bailey trusses, and cables, a suspension span was constructed here by the British IV Corps during the war. However, the bridge is in such a bad state of repair at present that it is in dangerous condition and needs replacement. It has a single-lane roadway, traffic being controlled from police booths at the ends of the bridge. The towers have no cross bracing nor struts, and are very badly out of vertical. It is understood that the Department expects to replace this structure with a two-span truss bridge located slightly upstream from the present site.

(d) At Takaw, Route IV crosses the Salween River, the service being afforded by a toll ferry the fee for which is K5 for a private car and K10 for a truck. It has been proposed that a bridge be constructed at this crossing, and on September 15, 1952 the consultant transmitted to the Secretary of National Planning and Religious Affairs his preliminary views on the design, type of structure, etc. Later, conferences were held with the Principal Works Officer, Shan States, and on December 10, 1952, recommendations for the crossing and estimates of cost were submitted to him. As a preliminary recommendation, three 240-ft. through-cantilever spans were called for, with concrete deck slab of 18 ft. clear roadway, and the total estimate of cost was K26·2 lakhs.

(e) **On Thingangyun Road,** the old location of Route I, the highway bridge over Pazundaung Creek was a victim of the hostilities and is not now in service. Several spans were demolished, and a considerable area and population north of the crossing no longer has access to Rangoon, except by a total travel of 80 miles.

The long-range program calls for the eventual replacement of the structure, which will have a total length of approximately 580 ft. The cost of the new structure will be approximately K21 lakhs. As a temporary expedient to again open the crossing to traffic, it is suggested that it would be possible to adapt the adjacent railroad bridge to also take the highway traffic.

The highway could be carried on embankment approaches to the railroad bridge, and then over the deck girder and through truss spans on a temporary heavy plank roadway between the inner rails of the two tracks. This would give a 7-ft. 6-in. roadway, less than the customary one-lane width. However, it would be adequate, on a controlled one-lane operation, and until highway and rail traffic picks up markedly and the major structure is replaced. It is estimated that the temporary relocation on the railroad bridge, with embankment approaches and pavement would cost about K2·3 lakhs.

(f) As indicated in the previous subsection, the cost of bridging the water gaps along Route VIII will prevent its being developed for some time as a continuous primary route into the lower Tenasserim. These gaps, served by ferry, are listed below, extending southward from the one over the Sittang River and with the mileages being measured from Payagyi, where Route VIII diverges from Route I.

Mile	*Crossing*	*Estimated Length*	*Ferry Toll*
37	Sittang River, near Mokpalin*	2,500 ft.	See below
127	Salween River, Moulmein	3 miles	See below
225	Ye Chaung	650 ft.	K5
352	Mindat Chaung	500 ft.	K3
372	Pe Chaung†	300 ft.	K3
387	Palauk Chaung	300 ft.	K3
409	Palaw Chaung	800 ft.	K3
443	Tamok River	1,050 ft.	K3
458	Kyaukpyu River	4,500 ft.	K5

The ferry tolls at the Sittang and Salween crossings are as follows:

Sittang River	*Rwy. Ferry*	*PWD Ferry*
Cars and Jeeps	K20	K20
Station Wagons and ¾-ton Trucks	K35	K30
3-ton Trucks	K55	K45

Salween River, Moulmein	*Ferry*
Jeeps	K15
Cars and Station Wagons	K20
¾-ton Trucks	K20
3-ton Trucks	K30

It will be noted from the location of the ferry crossings on Route VIII as above and as shown on Plate A, that the southerly seven crossings occur between Mile 352, which is 30 miles south of Tavoy, and Mergui, in a total distance of 115 miles. Except for the interruptions to through traffic in this rather short distance, and the cost of the three-mile structure needed at Moulmein, the rest of the route could be made reasonably continuous.

The most urgent of the crossings to be built is that at the Sittang River, and the very large structure at Moulmein should be undertaken ahead of the smaller ones to the south, as soon as funds become available. It is believed that the Sittang bridge should be built earlier than the bridge proposed over the Salween at Takaw.

(g) Starting at Hsenwi, on Route III, there is a graveled district highway extending eastward into Yunnan. Traveling generally down the valley of the Nam Nam River, it crosses the Salween River at Kunlong. It is proposed to construct a bridge at this location, and recommendations and a cost estimate were transmitted to the Principal Works Officer, Shan States, on December 10, 1952. It is proposed to use three 220-ft. through-cantilever spans with concrete deck slab having an 18-ft. clear roadway. The cost estimate was K23·6 lakhs for the total work.

(h) **Network deficiencies.** In addition to these physical and structural gaps in the present highway system, there are certain potential inadequacies in the highway network as a whole which in the long run will become evident. The river system of Burma is such that motor transport, and to a limited extent rail transport as well, has become an adjunct of waterborne shipping. Ships and river craft, of course, preceded both the railroad and the motor vehicle, but the development, especially in the last 25 years, of the latter two forms of competitive transport has been so phenomenal that a re-examination of the whole problem seems in order.

A striking thing about the highway system of Burma is that it hardly ever crosses a major waterway, except by ferry. There are over 5,000 miles of navigable water in the delta area; the Irrawaddy is navigable for 800 miles of its length in Burma; the Chindwin for another 400; and the Sittang and Salween are open to navigation for 350 and 50 miles of their respective lengths. But the only bridge crossing of any of these waterways, at present, is the combined rail and highway structure at Ava, south of Mandalay. This structure is not in service, nor has it been since its partial demolition in 1942. Except as the major connections are made by ferries, the over-all system therefore consists of a number of discontinuous pieces.

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* Now under design as a combined railway and highway bridge, and tenders will then be asked, with completion expected by 1958.

† Ferry during rainy season only. Low-level bridge used in dry season. The approaches at a number of these ferry crossings have poor alignment and grades and are difficult to negotiate, especially at low tides and after heavy rains. Delays too often occur in making the Palaw, Tamok and Kyaukpyu crossings.

As time goes on, and traffic develops, the need will arise for more adequate connection between all parts of the Union, and it is believed that the expanding highway network will have to include at least two more crossings of the Irrawaddy. The bridges to be built upon the present system have been indicated. In addition, the population and traffic growth will necessitate that crossings by bridge be provided over the Irrawaddy at Henzada, and between Magwe and Minbu.

Ultimately, it is possible that the Irrawaddy will also need to be bridged in the Myingyan region, and possibly at Prome; that the improvement of a primary highway between Bhamo and Katha may require another crossing of the Irrawaddy; and that the development of the Kalewa area may necessitate the replacement of the ferry over the Chindwin with a structure. Consideration should also be given to the possible future links between parts of the road network which are not adequately connected at present.

Based on traffic considerations, the arrangement of the existing network, the needs of the agricultural and urban population, the topography, and other physical features, it is suggested that on a long-range basis, the following extensions of the present primary system should be brought into being:

(1) Improvement of district highway east from Route III, at Hsenwi, to the crossing of the Salween at Kunlong, and on to Yunnan.

(2) A connection to Route VIII, at its upper end near Payagyi, extending westward to Tharrawaddy, on Route II, thence westward to and across the Irrawaddy at Henzada to serve the secondary network now existing west of the river.

(3) Complete the link between Maubin and the secondary system extending southward from Henzada.

(4) A cross connection between Routes I and II, in the Loikaw–Pyinmana region. Ultimately, it is believed that this should extend westward to Taungdwingyi and on to the Irrawaddy, with the river being crossed between Magwe and Minbu. The crossing would be 218 river miles above Henzada, and from Minbu to Mandalay is 203 river miles.

(5) Construct a connection between Routes II and I, extending from Prome to Toungoo, and there connecting to the west end of Route V.

(6) Extend the district road south from Maymyo to Lawksawk; then improve the existing road to Route IV, at Kalaw, or near Taunggyi.

(7) Improve and complete the highway from Katha to Bhamo as an east-west link between the district highways in that area.

(8) Improve Route VII between Shwebo and Kalewa at the time that traffic has shown the need for the bridging of the Chindwin, at Kalewa.

Judging from present trends, traffic and trade will develop in such order and to such degree that the improvements will become necessary in the order listed. Their construction, however, must also be integrated with the bridge projects proposed earlier in this subsection. Other future needs will also manifest themselves as the traffic increases.

7. HIGHWAYS TO ADJACENT COUNTRIES

Because of the topography and other physical features of this portion of southeast Asia, Burma is more or less isolated from her neighbors, except by water and air. The freight and bus traffic that at present moves across her borders is of small volume and importance. However, as the economy of the nation develops, and trade with close neighbors becomes necessary and desirable, the traffic on the highway routes to the borders of adjacent countries will increase in importance.

At present only three national highways reach the borders of Burma, as trade gateways. Route VI extends from Pangsau Pass, on the Indian border, to the border of Yunnan, east of Muse. The east end of Route IV is at Haung-Luk on the Indo-China boundary. Route VII, northward from Mandalay, reaches East Pakistan at Tamu.

Along the lower reaches of Route VIII, however, there are several district and secondary roads which extend eastward to enter, or at least reach, Thailand. These are all of minor importance at present but should develop, as trade arteries, when traffic grows and the roads themselves are improved. They include:

(**a**) The Bilin–Papun road, now 76 miles in length. Another 30 miles to the east, of which 22 are mule track, reaches Dagwin, where the Salween River may be crossed into Thailand.

(**b**) The Thaton–Hlaingbwe road, 48 miles in length. This includes a ferry crossing of the Salween at Pa-an, and the route extends, as a mule track, to Myawadi, on the Thai border.

(**c**) The Mudon–Kawkareik road also extends to the Thai border, with a total length of 124 miles.

(d) The Tavoy–Myitta road becomes a cart track and at Mile 66 the Thai border is reached.

The future planning for highway transport in Burma should include the development of each of these inter-country routes, to the appropriate degree, as channels for trade with neighbors. The improvement of Route VII, including a bridge over the Chindwin at Kalewa, has previously been indicated as a project in the future highway program.

D. TRAFFIC

1. MOTOR VEHICLE REGISTRATION

a. Procedure and Fees

At present, all privately owned cars in Burma are registered and licensed upon an annual basis (private cars and trucks) or a semi-annual basis (taxis, buses and common-carrier trucks). The proper registration is accompanied by the payment of a wheel tax, for the several categories and sizes of vehicles. The current schedule of such registration fees and wheel taxes is shown below, in Table XVI–2.

TABLE XVI – 2

REGISTRATION FEES AND WHEEL TAX, 1953

Vehicle	*Registration Fee*		*Wheel Tax*	
	Initial (kyats)	*Renewal (kyats)*	*Initial (kyats)*	*Renewal (kyats)*
Private Vehicles (annual renewal)				
Private Car, Jeep	16	2	50	50
Private Truck, 1 ton or less	16	2	120	120
Private Truck, 1–2 tons	16	2	150	150
Private Truck, over 2 tons	32	16	180	180
Each additional ton	—	—	30	30
Hire Vehicles (semi-annual renewal)				
Taxi	25	25	25	25
Truck, one ton or less	30	30	60	60
Truck, two tons	30	30	75	75
Truck, three tons	30	30	90	90
Bus, 14–16 passenger	30	30	50	50
Bus, 18–20 ,,	30	30	60	60
Bus, 24 ,,	30	30	75	75
Motor Cycle	4	2	20	20

Registration fees are placed in the general revenue account of the Government. Receipts from wheel taxes are used for street maintenance in corporations, and for district road maintenance in districts. In 1953, for the first time, vehicles of the Road Transport Board were registered and had fees paid thereon. As compared to the fees and taxes in force in January 1952, listed in the KTA preliminary report, it will be noted that there has been a sharp rise in the wheel tax, especially on heavier vehicles.

Later in this Report, it is recommended that a new motor vehicle code be enacted and placed in effect. In the draft, submitted herein, certain changes in the registration procedure and limitations are outlined. The new limitations should be based upon the accumulated administrative experience of the registration staff, modified by current experience elsewhere.

The main purpose of registration is to establish control by the regulatory body over the operation and use of the vehicles under its jurisdiction, largely in the interest of public safety and convenience, and only secondarily as a revenue measure.

The wheel tax, on the other hand, is the counterpart of revenue measures in force in many other places, and in many forms. Primarily it is the practical recognition of the fact that larger vehicles require heavier road and bridge structures for their support, and that in some way and to some degree, the contribution on the part of each vehicle should be in proportion to the share of the total cost for which the vehicle is responsible. In this connection, the matter of highway revenues is more fully discussed in Section M, Highway Financing, and other comparisons are drawn in Section E.

b. Vehicle Registration

Data on motor vehicle registration was assembled and studied in detail, to establish the nature and proportion, by categories, of the vehicles using the highways and streets of Burma. Table XVI–3A *(see p. 380)* shows the number of privately owned vehicles, by classifications, in each of the districts in Burma during 1952. As would be expected, the highest total registrations occur in the more populous districts. There is very wide disparity, however, in the case of Rangoon. The capital, with only 3·5% of the entire population, has registered in it more than 45% of all of the vehicles in Burma. Another difference of consequence is that while in Rangoon five eighths of the vehicles are either cars, jeeps or taxis, and that private and common-carrier trucks account for another quarter of the total registration, in the remaining districts only one third of all vehicles are cars, jeeps or taxis, while almost half of the total are trucks. Likewise, buses in the outlying districts make up more than one sixth of the registration, while in Rangoon the bus population is less than one eighth of the total. This greater usage of both buses for passenger transport and trucks, of both the private and common-carrier categories, is indicative of the essentially rural character of a larger part of Burma.

The 1952 vehicle registration figures for Rangoon indicate that there is one vehicle for each 71 people in the city. The corresponding figure for the Mandalay District is 1: 280, while those for Insein and Pegu Dis-

TABLE XVI – 3A

MOTOR VEHICLE REGISTRATION, BURMA, 1952

District	*Jeeps and Cars*	*Taxis*	*Trucks*		*Buses*		*Total*	
			Private	*Hire*	*Private*	*Hire*		
Hanthawaddy	36	13	114	21	4	203	391	
Insein	298	—	234	99	23	238	892	
Pegu	179	36	236	524	10	115	1,100	
Tharrawaddy	129	—	76	356	6	91	658	
Prome	92	1	37	285	—	37	452	
Toungoo	83	2	75	141	11	61	373	
Yamethin	49	4	4	158	—	12	227	
Kyaukse	19	—	14	1	8	49	91	
Thayetmyo	13	—	12	26	1	3	55	
Minbu	18	—	3	35	—	7	63	
Pakokku	14	4	1	53	—	6	78	
Magwe	41	—	72	60	1	9	183	
Myingyan	36	—	24	223	—	—	283	
Meiktila	98	—	65	284	3	—	450	
Mandalay	823	131	285	362	13	66	1,680	
Sagaing	31	1	1	14	1	110	158	
Lower Chindwin	30	—	11	96	—	2	139	
Upper Chindwin	13	1	12	41	—	—	67	
Katha	3	—	4	4	—	7	18	
Shwebo	38	—	6	123	2	58	227	
Bhamo	48	13	19	16	—	38	139	
Myitkyina	78	4	30	31	2	22	167	
Thaton	32	—	15	9	29	82	167	
Moulmein	231	—	82	57	54	172	596	
Chin Hills	6	—	17	—	—	—	23	
Tavoy	141	3	18	27	7	69	265	
Mergui	180	—	20	48	8	85	341	
Henzada	13	—	14	91	8	40	166	
Maubin	7	24	22	15	1	14	83	
Pyapon	1	—	—	—	—	—	1	
Myaungmya	14	—	1	—	4	27	46	
Bassein	33	7	23	7	3	15	88	
Sandoway	2	—	—	11	—	3	16	
Kyaukpyu	11	2	4	2	4	5	28	
Akyab	70	39	25	36	—	26	196	
S.S.S.	283	3	43	284	—	—	613	
N.S.S.	264	5	46	319	1	53	688	
Kayah	8	—	3	15	—	—	26	
Total, without Rangoon	3,468	293	1,668	3,874	204	1,725	11,232	54·5%
	33·4%		49·2%		17·4%			
Rangoon Town District	5,483	417	1,173	1,135	—	1,254	9,462	45·5%
Total, Burma	8,951	710	2,841	5,009	204	2,979	20,694	
	43·2%	3·4%	13·7%	24·3%	1·0%	14·4%		
	46·6%		38%		15·4%			100%

TABLE XVI – 3B

REGISTRATION OF MOTOR VEHICLES, BURMA, 1948–52

	1948			*1949*			*1950*		*1951*		*1952*		
	Rangoon Town	*Other Dists.*	*Govt. Vehicles*	*Rangoon Town*	*Other Dists.*	*Govt. Vehicles*	*Rangoon Town*	*Other Dists.*	*Rangoon Town*	*Other Dists.*	*Rangoon Town*	*Other Dists.*	*Classification*
Jeeps	2,743	3,450	318	2,865	2,852	320	5,154	3,049	4,803	2,856	5,483	3,468	Cars and Jeeps
Passenger Cars	2,912		454	3,033	1,027	454					417	293	Taxis
Light Trucks	218	9,800	281	220	384	281	2,245	6,220	2,370	5,917	1,173	1,668	Private Trucks
Heavy Trucks	3,335		2,799	3,344	9,909	2,799					1,135	3,874	Hire Trucks
											0	204	Private Buses
Buses	1,789	2,350	0	1,789	3,295	0	1,351	1,902	1,811	2,083	1,254	1,725	Hire Buses
Total, Major Vehicles	10,997	15,600	3,852	11,251	17,467	3,854	8,750	11,171	8,984	10,856	9,462	11,232	
Grand Total	30,449			32,572			19,921*		19,840*		20,694*		
Motor Cycles	1,102	1,000	420	1,165	737	424	628	639	468	550	Not available		

Sources: 1948, 1949, 1952: Office of Motor Vehicle Registration, Rangoon. 1950, 1951: KTA Preliminary Report, dated January 1952.
Notes. Light Truck: Less than 2 tons. Heavy Truck: 2 tons and over.
* Government vehicles not included.

tricts are 1: 495 and 1: 605 respectively. For the Union as a whole, there is one vehicle per 800 persons.

Table XVI–3B indicates the motor vehicle registration in Burma for the period 1948–52, the earliest for which adequate and reasonably accurate figures are available. The registration and record system has undergone several basic modifications during the four-year period, the definitions and categories of vehicles have been changed, and the protracted and severe (especially during 1949) conditions of insurgency have existed, and the direct comparison from year to year is almost impossible.

While motor cycles were enumerated during 1948–51, they have not been included in the totals of major vehicles, since their number and nature are such as to make them a negligible factor in vehicle and traffic studies. Figures for government-owned vehicles, which are registered in Rangoon but used in all parts of the country, are not available for years after 1949. However, if their number is estimated for these years on the basis of the 1948–49 figures, the total number of major vehicles, for comparative purposes, might be:

1948	30,449
1949	32,572
1950	24,230 (government vehicles estimated)
1951	24,170 ,, ,, ,,
1952	25,050 ,, ,, ,,

There appears to be a very large discrepancy between the 1948–49 totals, and those for the more recent years. This could be because of the confusions, and possibly over totals, during the period of extreme insurgency. However, it is certain that with the present insurgent activity, even though it be much lower than in previous years, there is an appreciable number of vehicles not included in the 1951 or 1952 totals shown. On this basis, and considering the relative importance of the insurgency factor and the administrative difficulties in carrying out registration procedure in predominantly rural areas, it is believed that the present number of vehicles in Burma, registered and using the highways, totals approximately 26,000 at the present time.

One of the most significant aspects of the comparative registration figures for different years, even for the short period for which figures are reasonably dependable and available, is the small growth of the vehicle population of Burma. Most of the heavier motor vehicles are either pre-World War II or are converted surplus military vehicles on hand at the end of hostilities.

As a measure of the low rate of import of motor vehicles in the postwar years, the United States exported 2·3% of the passenger-car production in 1950. Of these 120,000 exported vehicles, 13 came to Burma. Similarly, 11·3% of the US trucks produced that year were exported. None of these 125,000 vehicles were imported into Burma. The United Kingdom exported a total of 144,500 trucks in 1950, and 396,000 passenger cars.

At present, the condition is developing where the number of vehicles being retired, because of age and wear, exceeds the number being imported, and the total number of units using the highways is decreasing. With the growth in population at the rate now experienced, it is especially important that the number of trucks and passenger buses, already abnormally low with relation to the population, be increased so that it may furnish adequate transport for the increasing population and the developing industry and economy of the country. Specific proposals in this matter are made elsewhere in the Report.

c. Comparisons

As a matter of interest, in measuring the present status and intensity of motor vehicle transport in Burma with respect to other countries and places, the 1952 figure of one motor vehicle per 800 persons in Burma may be compared to the much lower ratios in Table XVI–4. Likewise, the truck ratio of one such vehicle to each 1,830 persons in Burma is compared with others in Table XVI–4.

While the number of persons per motor vehicle varies widely between countries, Burma and Turkey have comparatively low degrees of development of motor vehicle transport.

In this connection, it seems pertinent to retrace the early development of the motor car in the United States as measured by this factor. While the automobile appeared as early as 1895 (four vehicles were registered in the US in that year), 1900 really saw the beginning of its development as a transit vehicle. That year, there were 8,000 registered motor cars in the US, or one for each 9,500 persons in the country. As the number of cars very rapidly increased, this ratio decreased to one in 40 by 1915, to one in 11·5 in 1920, and to one in 4·6 by 1930. During the next ten years, in spite of the catastrophic effects of a widespread economic depression, this number continued to decrease, and by 1940 stood at one vehicle per each 4·1 persons. With the tremendous production of cars which occurred immediately preceding World War II, and from its end until 1950, the registration represents one vehicle for each 3·1 persons in the United States.

This was an average figure for the nation, and individual states had even lower ratios. Of the states listed in Table XVI–4, three had values of one vehicle per 2·3 persons, representing a use one third higher than the national average.

The relatively high proportion of trucks in Burma is very noticeable in the table, the figure being nearly twice that for Kansas and South Dakota, two predominantly agricultural states in the United States, and for Ceylon. The percentage of trucks in Burma is half again as great as that in Guatemala or Iraq.

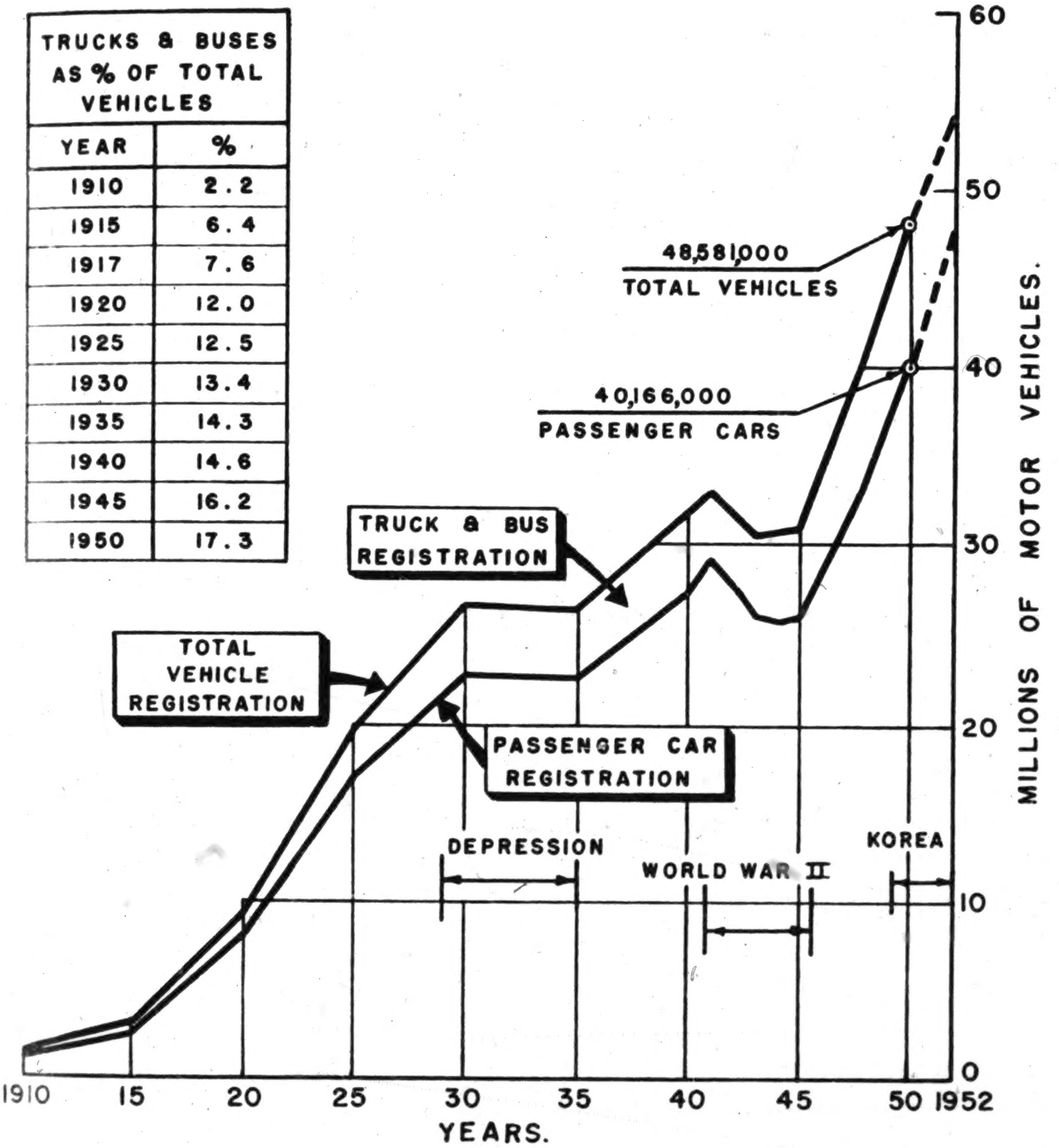
The total 1952 bus registration, in Burma, of 3,183 vehicles constitutes 15% of the entire vehicle registration. In the United States, the 1950 bus registration totaled 223,600 vehicles, just under 0·5% of the total vehicle registration. Of these buses in the US, one half were school buses. It is an almost universal practice, there, to furnish free bus transportation to public-school pupils in rural and small urban areas. In Ceylon, buses total only 6·5% of the total registration, while in Turkey and Guatemala the proportion is 12%, and in Iraq 18%.

TABLE XVI – 4

MOTOR VEHICLE REGISTRATIONS AND RATIOS

	Total Vehicle Registration, 1950	*Persons per Vehicle*	*Truck Registration, 1950*	*Persons per Truck*	*Trucks, as per cent of Total Vehicles*
Burma (1952)	25,050	800	10,930	1,830	43·5
Entire U.S.	49,161,700	3·1	8,604,000	18	17·5
Iowa	1,072,300	2·5	187,500	14	17·5
Kansas	853,500	2·3	202,700	10	23·8
Ohio	2,795,100	2·9	350,100	23	12·5
California	4,620,000	2·3	652,000	16	14·2
South Dakota	290,100	2·3	73,100	9	25·0
Iraq	14,475	332	4,367	1,098	30
Ceylon	49,284	153	11,827	640	24
Guatemala	12,754	291	3,593	1,035	28
Turkey (1948)	26,985	728	11,300	1,465	42

TRUCKS & BUSES AS % OF TOTAL VEHICLES	
YEAR	%
1910	2.2
1915	6.4
1917	7.6
1920	12.0
1925	12.5
1930	13.4
1935	14.3
1940	14.6
1945	16.2
1950	17.3



NOTES:-

PASSENGER CARS INCLUDE TRUCKS WITH CAPACITY 1500 LBS. & LESS.

MINISTRY OF NATIONAL PLANNING

HIGHWAYS

MOTOR VEHICLE REGISTRATION
IN UNITED STATES
1910—1952.

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK. RANGOON

DR. BY. E.J.P. DATE JUNE 53 PLATE NO. 2
CK. BY. K.B.W.

Since motor cars in appreciable numbers have only been used in Burma for a limited number of years, considering the life of the motor vehicle, no well-defined trend as to the vehicle population is available. The relative cost of cars and the problems of import for both vehicles and parts are both obstacles to a very rapid growth in vehicle registration and use in the foreseeable future. Such growth has occurred in the United States through the past 40 years, as shown on Plate 2 and as discussed above.

Passenger-car registration in the US had risen to 458,000 vehicles by 1910, and the figure climbed rapidly through the years, with a leveling off during the depression years (1929–35) and a minor setback during World War II, reaching a total of more than 40 million pleasure vehicles in use in 1950. Likewise the number of trucks and buses in use in the United States mounted rapidly during the entire period from a modest 10,000 heavy vehicles in 1910 to a 1950 total of 8,415,000 units.

The growth in the number of motor vehicles in use in the United States has been amazingly great, especially in the period since the end of World War II.

As to passenger cars, the vehicle registration doubled between 1918 and 1922, doubled again between 1922 and 1927, and still again between 1927 and 1933. During the depression, the number of vehicles registered did not increase and the war years (1941–46) saw a further setback in the trend. However, the total number doubled again in the period 1933–50. The increase for the last several years has been at the rate of about 9% per year. On this basis, the 1950 total of 40,166,000 passenger-car registrations seems likely to double again by the year 1958, unless there is a major economic catastrophe or a major war.

The increase in registration and use of trucks and buses has been even more spectacular. The 1950 truck registration (8,272,000 vehicles) is half again as great as that in 1946, and almost double that in 1938. Buses have doubled in number between 1940 and 1950 (for which latter year the registration was 143,200 privately owned vehicles).

The table shown on Plate 2 brings out this trend, one which would probably always occur to some degree in a country which was developing agriculturally and industrially. Consistently during the entire 40-year period, the proportion of trucks to total vehicles registered has been increasing in the US, and by 1950 more than one sixth of the vehicles were of the heavier types.

Since the proportion of trucks to total vehicles in Burma is already approaching one half, it seems extremely unlikely that the changing in this proportion will occur as rapidly here as it has in the United States in the last ten years. With the advancing industrialization of Burma, however, and with improving agriculture, and assuming that the recommended remedial measures as to customs and finance have been taken, the increase will occur, and the long-range highway and traffic planning must recognize this fact.

Study of the increasing use of trucks as compared to pleasure cars brings out another factor in the overall plan, one which has been recognized in the proposed Motor Vehicle Code in Section N of this chapter.

From the statistics on US highways it can be established that heavy multiple vehicles (trucks and combinations) hauled 36% more ton-mileage of freight in 1950 than in 1949 and over 100% more than in 1941. This increase resulted largely from an increased usage of commercial vehicles of all types, but particularly from the greater proportionate use of combinations. The average carried load for all trucks and combinations in 1950 was 10% above that in 1949 and 55% above the 1941 figure. Another important factor in the increase in ton-mileage has been the increase in the percentage of trucks and truck combinations that are loaded, which, from 1949 to 1950, increased from 51·5 to 54% of all such vehicles.

The frequency of heavy gross loads has been increasing, with the occurrence of loads of 30,000 pounds or more per 1,000 vehicles being 26% more in 1950 than in 1949, and almost 30% more than in 1945, the previous year of highest frequency of such loads. The increase in frequency of loads of 50,000 pounds and over per 1,000 vehicles is even more striking, the 1950 figure being 61% above that in 1949 and 152% above 1945.

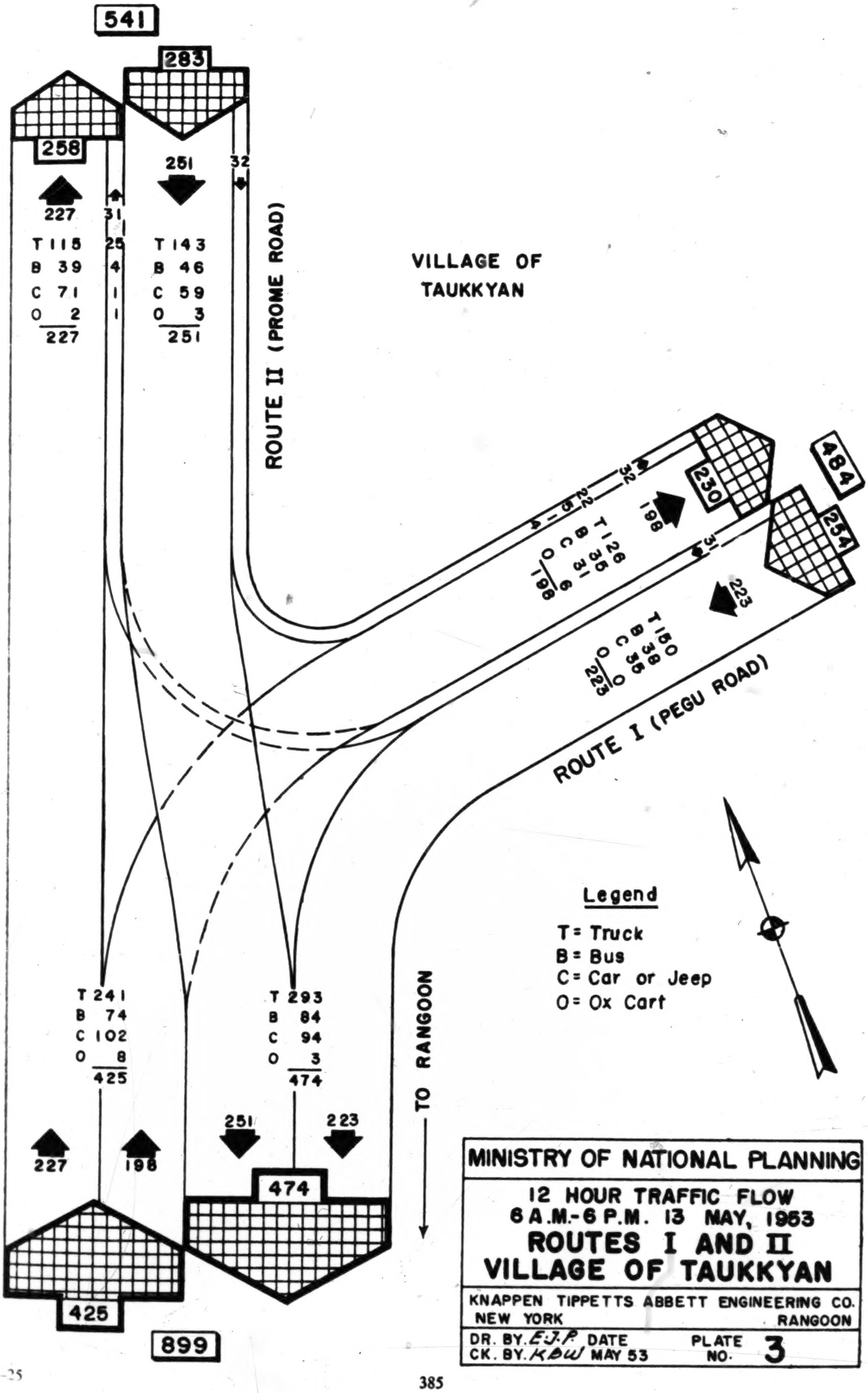
There are indications that more attention is being given to proper load distribution and observance of axle-load restrictions, since there is a leveling off in the frequency of heavy axle loads. The frequency of axle loads of 20,000 pounds and over was lower in 1950 than in 1948.

The tendency toward heavier and heavier loads in truck operations is thus shown, and adequate registration and enforcement must be carried out by all units of Government in Burma if pavements and structures are not to be damaged by the overloads, as has been true in some of the states in the United States. Even with the axle loads restricted to much lower values, as in the recommended code, the tendency to overload will still exist as a source of failure and needless expense.

2. PRESENT TRAFFIC

a. Rural Traffic

Except immediately adjacent to the larger communities in Burma, the rural traffic upon the highways is not heavy. There are, as in traffic flow in much more


541
283
258
251
32
227
31
25
4
1
1
T 115
B 39
C 71
O 2
227
T 143
B 46
C 59
O 3
251
ROUTE II (PROME ROAD)
VILLAGE OF TAUKKYAN
230
484
254
32
22
5
4
198
T 126
B 35
C 31
O 6
198
31
223
T 150
B 38
C 35
O 0
223
ROUTE I (PEGU ROAD)
Legend
T = Truck
B = Bus
C = Car or Jeep
O = Ox Cart
T 241
B 74
C 102
O 8
425
T 293
B 84
C 94
O 3
474
TO RANGOON
227
198
251
223
474
425
899

MINISTRY OF NATIONAL PLANNING

12 HOUR TRAFFIC FLOW
6 A.M.-6 P.M. 13 MAY, 1953
ROUTES I AND II
VILLAGE OF TAUKKYAN

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. E.J.P. DATE PLATE
CK. BY. KBW MAY 53 NO. 3

developed areas and transport systems, certain patterns and peak traffic loads, but with only a moderate total volume, these generally do not cause congestion and undue delay at the present time. However, with the proposed rehabilitation of the entire highway system, it will be well to eliminate as many of the points of serious present congestion as is possible. Also the improvements and new increments of the network should be so planned as to permit growing traffic to move expeditiously, conveniently and safely, and thus to avoid the costly and inconvenient relocations and corrective modifications, etc., which would otherwise have to be made.

While the limitations of time, and to an even greater extent those of insurgency, have prevented the making of complete traffic counts and surveys, a beginning has been made in this direction. With the techniques, short cuts, and the processes of partial sampling that have been developed in countries where vehicular traffic has become a serious engineering and economic problem, it is easily possible to conduct such surveys, to analyze the results, and to establish the several aspects of the total flow. This data, properly analyzed and wisely interpreted, will serve as the criteria for the basic design for both present and future conditions of that portion of the network that is under consideration.

As an example of the procedure and also to establish the basic traffic data for Routes I and II in the Rangoon area as an aid in the planning of local improvements, 12-hour traffic counts were made on May 13, 1953, in the village of Taukkyan, for traffic in each direction on the two routes. The 12-hour total counts, by categories of vehicles and by direction, are shown on Plate 3. In addition to the basic volumes shown the following corollary facts appear:

The turning movements (southbound from Route I and east into Route II, and north from Route II into Route I) are small, totaling only 11 to 12% of the total movements. The intersection, which is 21 miles from downtown Rangoon, is sufficiently rural that the proportion of truck traffic resembles the "up country" pattern of Table XVI–3A rather than that of Rangoon Town. Of the total 12-hour flow, 57–67% is truck traffic. The proportion of buses was 15–17% of the total flow, approximately the same proportion as exists in both the Rangoon and "up country" registration.

This close to Rangoon, the proportion of ox carts was abnormally low, as compared to more rural areas not too much farther from the capital. The animal-drawn vehicles constituted only 1% of the total flow. Possibly too, with rice plowing in its early stages, this fact had a bearing on this low proportion. It was established from the count, and supplementary counts, that except for Sundays, there is no especially noticeable variation in traffic volume due to the day of the week.

As a start on the making of fractional counts, it was found that the most consistent flow occurred during 7–8 a.m. and 9–10 a.m. and that the flow during each of these two one-hour periods was close to 10% of the daily (i.e., 12-hour) flow. As would be expected from the location with respect to Rangoon and smaller communities in the area, and from normal working hours, bus traffic was heaviest between 7 and 9 a.m., this period accounting for more than a fourth of the total daily bus count.

Although no exact conclusion was drawn, it appears that the rain storms of short duration served only to delay the anticipated bus and general flow by about the same amount of time, and had no other significant effect. The total 12-hour flow below the intersection (i.e. toward Rangoon) was 899 vehicles, that on Route II to and from Prome totaled 541 vehicles, and that on Route I toward Pegu totaled 484.

Insurgency, as it now prevails, prevents night travel, but the travel day is more nearly 14 hours in length than the 12 measured. On this basis, and projecting the trends at the start and end of the day, it appears that the combined flow, below Taukkyan, would total about 970 vehicles, the Prome (II) and Pegu (I) full day flows being 580 and 515 respectively. The tabulations of the hourly flows for the 12-hour count on the two routes is shown in Table XVI–5.

During the period of field investigation, traffic counts and spot checks were made at various locations on the rural highway network, and from this data, approximate daily totals were developed. These totals, the locations at which counts were made, and pertinent data are shown in Table XVI–6 (*see p. 388*).

b. Urban Traffic

Of the cities in Burma, only the four or five largest have traffic problems resembling those currently troubling cities in the United States and Europe where the vehicle population is proportionately greater. There are local problems in the smaller communities, but these are in part due to local development and in part due to highway routing as affected by topography, direction of other roads in the area, watercourses, etc. In the larger cities, these factors plus those of vehicle volume and inadequate control give rise to traffic congestion and delay.

While at present the congestion and delay in most cases are not severe nor protracted enough to cause economic loss to the motoring and general public, the situations should be corrected in an orderly and planned manner, to the end that developing traffic may flow through the cities as smoothly as possible.

TABLE XVI - 5

HOURLY TRAFFIC FLOW, TAUKKYAN, MAY 13, 1953

		Route I Traffic							*Route II Traffic*							
		Trucks	*Buses*	*Jeeps or Cars*	*Ox Carts*	*Totals*			*Trucks*	*Buses*	*Jeeps or Cars*	*Ox Carts*	*Totals*			*Per cent*
						S	*N*	*All*					*S*	*N*	*All*	
A.M. 6-7								54							42	7·8
	S	15	2	2	0	19			11	3	2	0	16			
	N	30	3	1	1		35		20	2	4	0		26		
7-8								52							49	9·1
	S	11	10	2	0	23			11	7	2	1	21			
	N	22	2	5	0		29		19	6	3	0		28		
8-9								58							51	9·5
	S	20	8	1	0	29			17	6	4	0	27			
	N	20	5	3	1		29		13	3	7	1		24		
9-10								46							55	10·2
	S	12	5	3	0	20			16	5	4	2	27			
	N	12	5	5	4		26		16	3	8	1		28		
10-11								40							46	8·5
	S	16	5	5	0	26			11	6	1	1	19			
	N	5	5	3	1		14		12	5	10	0		27		
11-12								48							43	7·0
	S	18	3	6	0	27			11	3	7	3	24			
	N	12	3	3	3		21		9	3	7	0		19		
P.M. 12-1								26							32	5·9
	S	13	2	1	0	16			14	3	4	0	21			
	N	7	2	1	0		10		6	3	2	0		11		
1-2								48							55	10·2
	S	27	3	1	0	31			19	2	10	0	31			
	N	12	3	2	0		17		13	2	9	0		24		
2-3								22							38	7·0
	S	12	0	2	0	14			10	1	8	0	19			
	N	2	2	4	0		8		11	3	5	0		19		
3-4								39							41	7·6
	S	17	1	7	0	25			18	1	5	0	24			
	N	9	3	2	0		14		9	3	5	0		17		
4-5								22							57	10·4
	S	10	2	2	0	14			19	7	9	0	35			
	N	6	2	0	0		8		5	9	8	0		22		
5-6								29							32	5·9
	S	5	1	4	0	10			8	7	4	0	19			
	N	11	5	3	0		19		8	1	4	0		13		
Totals:	S/N	176/148	42/40	36/32	0/10	254/230			165/141	51/43	60/72	7/2	283/258			
	All	324	82	68	10	484		484	306	94	132	9	541		541	100
		67%	17%	14%	2%	100%			57%	17%	24%	2%	100%			

Notes: Route I. 8–9 a.m. flow—12% of 12-hour total.
6–9 a.m. flow—34% of 12-hour total.
Of 324 trucks, tally sheets indicate that eight were "heavy" (greater than five tons).

Notes: Route II. 9–10 a.m. flow—10·2% of 12-hour total.
7–10 a.m. flow—28·8% of 12-hour total.
Of 306 trucks, nine were "heavy".

General Notes: Recorders: U Kin Maung, Tin U Kyaing.
During day, three 20-minute rains occurred.
For turning movements, see Plate 3.

In Rangoon, as a direct example, the traffic congestion that develops every week-day afternoon between 4.30 and 6 p.m. along Commissioner Road and especially at its intersection with Sule Pagoda Road is severe enough to require immediate attention. The traffic flow along Commissioner Road has a maximum observed value of about 1,200 vehicles per hour at this time of day while that along Signal Pagoda and Sule Pagoda Roads simultaneously totals 1,130 and 1,220 vehicles per hour respectively. Montgomery Street adds 950 vehicles per hour to the total. This total congestion, with the present layout and grading

TABLE XVI – 6

OBSERVED TRAFFIC DENSITIES, 1952–53

Route	*Vehicles per day*	*Location of Count*	*Date of Count*	*Remarks*
I	750 (2 counts)	South of Taukkyan and near Pegu	June 27	95% trucks and buses
I	290	Near Kyaukse	October 16	
II	380	15 mi. south of Tharrawaddy	July 7	90% trucks and buses
II	200	10 mi. south of Prome	July 8	90% ,, ,, ,,
III	440	West of Maymyo	October 17	—
III	170	Near Kyaukme	October 18	—
III	125	South of Lashio	October 18	—
IV	90	West of Kalaw	January 9*	—

(On Route IV, between Thazi and Loilem, the count does not exceed 120 vehicles per day except close to the larger towns.

On the secondary roads around Taunggyi (January 7, 1953) the traffic counts do not exceed 30 vehicles per day.)

Route	*Vehicles per day*	*Location of Count*	*Date of Count*	*Remarks*
IV	80	South of Hsenwi	November 16	—
Secondary Road, IV to III				
VII	450–500	East of Sagaing	October 14	—
VII	275	North of Sagaing	October 15	—

Notes: All traffic counts include bullock carts.
Dates of counts are 1952, except those starred (*) which are 1953.

of the traffic circle, necessitates the use of two, and often three, policemen to direct and control the flow of traffic. Concrete recommendations are made (Section Q, paragraph 3), for the modernization of this intersection to improve the traffic flow in the area.

Likewise, the traffic flows at a number of other intersections in the area were studied, and recommendations are also made for the improvement of a number of these where the solution is simply a matter of modernizing the intersection to conform to developing traffic and current good highway practice.

The traffic densities along some of the main arteries and at the more important intersections were established in June–July 1953, the values being tabulated below:

At the Myenigon Circle, on Prome Road:
360 vehicles per hour on Prome Road, and 66 on Bagaya Pongyi Road, with approximately 15% of the vehicles engaged in turning movements.

Along Prome Road:
480 vehicles per hour, midway between U Wisara Road and Victoria Road. Of this total, 18% were buses and 12% trucks.
350 per hour, just north of Myenigon. One third were buses and 15% trucks.

At the U Wisara–Hanthawaddy Circle, on Prome Road:
420 vehicles per hour through the intersection, almost two thirds being along Prome Road.

These are just a small number of the intersections in Rangoon at which traffic counts should be made periodically to establish the trends in traffic flow and to obtain fundamental data for the planning of improvements to the urban highway and street network of the capital. The administrative arrangement for the responsible group to undertake this and the other planning functions is shown in Plate C and specific recommendations are also made along this direction.

Traffic congestions sometimes develop in an accumulative manner, in which gradually through the years practices are permitted which cause encroachment, little by little, upon the traveled way. Each restrictive practice, in itself, does not reduce the capacity of the roadway nor hamper the movements in the intersection, but the whole effect impedes the vehicular traffic and thus still further reduces the free flow.

As an example, there is cited in Section C (see Plate B), the existing condition of the Canal Street–

China Street crossing in Rangoon. The intersection is one of the busiest in downtown Rangoon, and all possible impediments to smooth traffic flow should have been guarded against. This would not have been a difficult task. Instead, the combination of circumstances makes it one of the most chaotic crossings in the city, even at mid-day. A conscientious and competent traffic engineering group will be ever watchful of bad developments of this kind, and will see that the necessary preventive and regulatory police measures are taken.

Since the systematic planning and carrying out of municipal highway and street improvements will, at least for some years, be a departure from the present practice, the officials of the local communities will need assistance in gaining the experience that must go into this kind of study, planning and construction. As indicated in the recommendations, strengthening of the planning group in the Public Works Ministry is needed to carry the increased responsibilities that go with the rehabilitation program. For municipal improvements, the planning group will have to establish geometric standards, grades, drainage standards, minimum requirements for access and many other such factors in the design; will have to assist in the preparation, or prepare, the plans and specification for the work; and will then have to give guidance and counsel in the carrying out of the construction. With maintenance also a partial responsibility of the national government, maintenance programs and procedures will have to be set up, in order that the work done may be properly cared for, kept in a serviceable and useful condition, and not be permitted to deteriorate.

In planning for the rehabilitation of the highway system of Burma, it was found that a vital part of the improvement program must be local improvements in the towns and villages. In the past the growth of the smaller communities has been a haphazard and unplanned development, and this is characteristic of the routing of the national and district roads through these cities and towns, especially the latter. From the study that was made of the highway and traffic conditions in these urban areas, certain basic items developed as a common need of almost all of the communities, and these have been included in the recommendations of the Report.

The planning of a program of urban highway improvement for any particular city must be a cooperative enterprise between the national and district governments on the one hand, and the local authorities. One of the prime factors in the planning is the flow of traffic in the area, and since local traffic regulation and enforcement can either aid or impede this flow, it is necessary that the local police officials and other municipal authorities share in the over-all planning and carrying out of the improvement. Likewise, the municipal officials have an intimate and day by day knowledge of local problems, and what other improvements (such as housing, sewers, drainage) are in prospect and should be integrated with the highway and street program.

It has been found in the United States, where motor vehicle traffic is highly developed, that the effect of dense urban traffic extends, to a decreasing degree, some distance away from the center of the community, which is generally in the downtown business district. This effect is only general in nature, and no precise rules can be set down for its extent. However, studies of a large number of American communities indicate that the radius of effect of urban traffic begins to be appreciable at about these distances from cities and towns:

Population	*Radius of Effect** (*miles*)
300,000–1,000,000	25
100,000–300,000	15
50,000–100,000	12
25,000– 50,000	9
10,000– 25,000	6
5,000– 10,000	3

* Measured from downtown business section.

While the effect is not felt so strongly, nor for as great a distance, in the corresponding cities and towns in Burma, since the vehicle densities are much less, the relationship manifests itself in the same manner. Based on the field studies of urban traffic here, it is believed that the effect exists to an appreciable degree for a distance of 3½ to 4 miles from cities of 10,000 to 25,000 population and 2 miles for towns in the 5,000 to 10,000 class. This means that in making improvements in a community the planning will have to consider developments within a circle of at least this radius, if the future growth of the community and its developing traffic are not to be adversely affected.

3. POPULATION FACTORS

a. General

In developing a long-range plan for highway development, one of the main influences upon traffic is found to be population, especially its distribution in urban areas. As population grows, so does traffic volume, and especially travel by public vehicles in urban areas, and between urban areas. Likewise, truck traffic between cities and towns increases, as the need to transport food and other commodities increases. The number and use of passenger cars, taxis and other types of motor vehicles increases correspondingly.

The increase in motor vehicle traffic may, in some cases, be accompanied by significant shifting in the use and type of motor vehicles. As a community grows, the use of public transport becomes more and more necessary, if traffic congestion in closely built-up areas is to be avoided, or its results minimized.

As the population shifts within a local community it may also become necessary in the interest of proper civic development and of accommodation, both local and through traffic, to re-route the main highways through the community, and even to replan and relocate local streets to expedite the flow of traffic.

All of these operations are costly, in developed areas, both in construction and land acquisition, and the carrying out of the construction also results in major inconveniences to both the traveling public and the local residents and shopkeepers. In addition, in the larger communities, where there are extensive electrical, water, and other utility installations, there will be still further expense and inconvenience involved in the relocations which accompany the road and street modifications.

For all these reasons, then, it is necessary that the proper weight and consideration be given to the factors making the relocation and reconstruction necessary, one of the most important influences being that of population, its distribution, and trends.

b. Census of Urban Population, 1953

There was conducted in Burma, in 1953, and to the degree possible under conditions of insurgency and local unrest then prevailing, a population census of cities, towns and villages. The resulting figures may be summarized as follows:

242 cities, towns, and villages had a total population of 2,843,135.

Excluding the 22 villages enumerated for which the population was less than 1,000, 220 cities and towns had a total population of 2,826,991.

Of these, the five largest cities had a total population of 1,133,655 persons, divided as follows:

1. Rangoon (Town)	711,520	
2. Mandalay	182,367	
3. Moulmein	101,720	
4. Bassein	77,382	
5. Henzada	60,666	
		1,133,655

The remaining 215 cities and towns, each having a population less than 50,000, are distributed numerically as follows, for size:

8	30–50,000	14	8–10,000	30	3–4,000
13	20–30,000	15	6– 8,000	33	2–3,000
16	15–20,000	17	5– 6,000	36	1–2,000
12	10–15,000	21	4– 5,000		

For the purpose of this section of this Report, as relating to highway programs, classifications, etc., the communities will be classified as follows:

Major Cities	Population over	50,000	5
Other Cities	,,	20–50,000	21
Towns	,,	5–20,000	74
Villages	,,	1– 5,000	120
			220

c. Urban Densities

In planning the local improvement program, consideration was given to planning the street improvements in proper relationship to the population and areas of the communities involved. The relationship between population, developed area of the community and highway and street lengths within this area, is subject to variation from a number of factors. The more important factors are the population of the community, its basic nature, its stage of development, topography, barriers to expansion.

In developing the details of the local projects in the first stage of the highway rehabilitation and improvement program, it was found that with a few explainable exceptions, the population-area relationship was fairly consistent. The following cities will serve as examples:

	Density (persons per square mile)
Mandalay	10,200
Henzada	25,100
Prome	25,500
Myingyan	24,400
Chauk	28,400
Pyinmana	18,700
Meiktila	18,500
Shwebo	20,800
Thayetmyo	14,700

The density is based on the area of the developed portion of the city, as observed or established from local maps. These are very high densities, as compared to cities in the United States. Nine comparable American cities of populations between 40,000 and 220,000, based on the 1950 census, were compared to those above. It was found that the average density was approximately 7,700 persons per square mile; the figure varying from 6,200 to 9,800. The disparity between the cities in Burma and those in the United States, however, is not as great as the figures show, since the areas in the United States are those within the corporate limits. These are often somewhat beyond the limits of the present developed area. As a result it is believed that the average density value in the US would be approximately 9,000 to 10,000 persons per square mile, based on the developed area.

This compares to a reasonable average of 23,000 persons per square mile for the Burmese communities. This relatively high density produces no immediate problem, insofar as general traffic is concerned, due to the relatively small number of cars in most of the communities, as indicated in the vehicle registration figures in Table XVI–3A. It does point, however, to one serious current need, and this is borne out by common experience in and between a number of communities. The facilities provided for travel by bus are very inadequate, almost all vehicles in and between local communities are much overcrowded, and the service in general is not good.

As a long-range problem, the overcrowding of cities and towns will produce traffic congestion of a very serious nature, as the number of motor vehicles increases, and the use is intensified. For this reason careful planning of highway improvements is especially necessary. Many of the decisions taken in this direction will commit and influence the future development of the communities, and the long-range trends of population, community development and motor vehicle traffic.

d. Urban and Rural Population

It was necessary in establishing the basic trends of highway traffic, and its proper accommodation upon the highway network, both existing and as planned for future development, to establish the relative population as between rural and urban areas, in the districts, divisions and the autonomous states of Burma.

Because of insurgency, no decennial census was made in 1951 in Burma. Based on the growth patterns indicated by the 1931 and 1941 censuses, and the much more rapid increase in the population of the urban areas, as revealed by a comparison of the 1941 and 1953 urban censuses, factors of increase were set up for the various parts of the nation. From these data estimates were made of the rural, urban, and total population in each of the political subdivisions in Burma. These estimates are shown in Table XVI–7 (*see next page*). Also shown in the table are the estimated total populations of the divisions and of the eastern States. For the latter, no current figures are available as to urban population, and total estimates only could be made.

As shown in the table, the total population of Burma in 1951 is estimated to be 19,250,000, of which 2,940,000 (15·3%) are urban and 16,310,000 (84·7%) are rural residents. Almost half of the total population lives in the southerly three divisions (Pegu, Irrawaddy and Tenasserim) and if the Magwe and Mandalay Divisions are added, more than two thirds of the nation's population is accounted for.

The Pegu Division, which includes Rangoon, has an urban population which is 33·8% of the total. The urban percentages for other divisions are materially less, the second largest being the Mandalay Division, in which 18·5% of the population is urban. In four of the light divisions the urban population is less than 10% of the divisional total.

4. TREND AND ANTICIPATED TRAFFIC

The growth of motor vehicle traffic in Burma has been a sporadic and irregular matter, largely affected by extraneous influences for which no known experience factors can serve as a basis of estimate. Previous to World War II there were only a few motor vehicles in the whole Union. Military operations, and especially the transport and logistical problems created thereby, brought a great number of vehicles to Burma, but the majority were either for the haul and use of military equipment or for military personnel. Many of these vehicles remained here after the end of hostilities, and of these a considerable number—possibly 3,500—are now in use by the army of the Union. The vast majority, however, were immediately put to civilian use, either directly or after being converted. In this way, the number of trucks and buses in use became a very large proportion of the total number of registered vehicles.

Even so, there is a deficiency of vehicles in Burma, especially those for public hire and transport of passengers. The older vehicles now operating on the streets are from eight to ten years old, have been subjected to very severe operating conditions (as a result of the rough and otherwise maltreated and neglected pavements encountered since the war and insurrection) and cannot continue to operate much longer. Actually, at present, the loss due to "wearing out" is slightly greater than the increase each year due to import of cars.

Probably one of the most striking features of traffic in Burma, to the casual observer who has comparable experience elsewhere, is the persistent and almost complete overloading of hire vehicles, especially buses. On a recent field trip, for example, it was observed that a bus designed for 18 passengers, seated, was carrying a total of 46, including the two spare-men and three other passengers who were standing on the rear bumper of the bus and precariously clinging to the rear portion of the body. Such conditions are very common, and can be observed in every community and on the open, rural road as well. Buses so overloaded are a menace to the safety of the passengers, and to occupants of other motor vehicles as well.

The truck condition is scarcely better. Very heavy and bulky loads are often placed on the tops of truck bodies, thus raising the center of gravity of the loaded vehicle to an alarming degree. And more and more, of

TABLE XVI – 7

ESTIMATED POPULATION OF BURMA, 1951

(in thousands)

	Total 1951	*Division Total 1951*	*Urban 1951*	*Rural 1951*
Arakan Division		1,350	(7·3%)	(92·7%)
1. Akyab	866		68	798
2. Arakan Hill Tracts	39		6	33
3. Kyaukpyu	287		16	271
4. Sandoway	158		9	149
Pegu Division		3,470	(33·8%)	(66·2%)
5. Rangoon Town	676·4		676·4	0
6. Pegu	663·6		158·6	505
7. Tharrawaddy	668		98	570
8. Hanthawaddy	523		50	473
9. Insein	441		112	329
10. Prome	498		81	417
Irrawaddy Division		3,030	(12·6%)	87·4%)
11. Bassein	757		103	654
12. Henzada	790		91	699
13. Myaungmya	556		76	480
14. Maubin	488		48	440
15. Pyapon	439		64	375
Tenasserim Division		2,405	(15·5%)	(84·5%)
16. Salween	65*		8*	57*
17. Thaton	676		70	606
18. Amherst	677		138	539
19. Tavoy	241		41	200
20. Mergui	206		39	167
21. Toungoo	540		77	463
Magwe Division		2,170	(8·7%)	(91·3%)
22. Thayetmyo	338		39	299
23. Minbu	345		13	332
24. Magwe	638		73	565
25. Pakokku	637		45	592
26. Chin Hills	212		18	194
Mandalay Division		2,175	(18·5%)	(81·5%)
27. } 28. } Mandalay incl. Town	466		222	244
29. Kyaukse	174		15·5	158·5
30. Meiktila	392		37	355
31. Myingyan	614		71·5	542·5
32. Yamethin	529		57	472
Sagaing Division		2,630	(6·8%)	(93·2%)
33. Bhamo	147		9·5	138·5
34. Myitkyina	340		14·5	325·5
35. Shwebo	547		42·5	504·5
36. Sagaing	441		32·5	408·5
37. Katha	332		18	314
38. Lower Chindwin	488		40	448
39. Upper Chindwin	239		13	226
40. Naga Hills	96*		8*	88*

TABLE XVI – 7 (*continued*)

	Total 1951	*Division Total 1951*	*Urban 1951*	*Rural 1951*
Eastern States		2,020	(7%*)	(93%*)
North Shan States	788			
South Shan States	1,058			
Karenni	80			
Wa	94			
Total Estimated Population, Burma, 1951		19,250	2,940	16,310
Per cent of Total Population			15·3	84·7

Notes: Urban: Includes all communities of 1,000 or more.
Rural: Includes rural and all communities less than 1,000.
* Estimated.

late, the overcrowding of the buses has caused truck operators to engage, on the side, in the bus transport business. Many loaded and nearly loaded trucks are observed to be carrying two to five passengers, in addition to the working crew. This unregulated and illegal practice should be stopped at once, as it also creates a dangerous condition in traffic.

With a demonstrated shortage of vehicles for the passengers and goods now desiring to be carried by public transport, the Government should exercise every effort to improve the conditions for the import of vehicles, to take the place of those worn out and no longer on the highways, and additional vehicles, especially trucks and buses, to serve the increased traffic already desiring such service.

As to the rate at which the traffic will increase, the answer is difficult to make. Total registrations in countries where the vehicle population is low can increase more rapidly than ones in which the number of cars and trucks is already substantial and somewhat stabilized. On this basis, and if there were no import restrictions to impede the process, it seems possible that the vehicle population in Burma, and thus the total traffic, could double in the next five years. However, the import exchange obstacles cannot be completely removed even if the recommendations are effectively put into force. On the basis of experience in evaluating factors of this nature, it is estimated that the vehicle registration in the Union will increase by one third in the next five-year period. Thus, by 1958, the vehicle population of Burma would be approximately 35,000. It is suggested that the highway planning and expenditures be geared to that level of growth.

Betterment of the conditions of the Union roads, especially the national system as recommended below, will bring about an increased use by vehicles of all roads, and this increased road usage will also be an important growth factor.

5. THE OX CART

One of the problems that has plagued the Department of Building and Roads, and its predecessor bodies, is that of the accommodation of the ox cart upon highways with mixed traffic, traveling at differing speeds.

Based on the best available data on agriculture, in 1948–49, it can be demonstrated that there are 1,500,000–1,700,000 ox teams in Burma at the present time. While the larger figure is subject to some qualification, there are certainly not less than one and one half million teams in service, and occasionally using the public highways of the Union. On the basis that these bullock teams are in use by the owner-cultivators, for plowing and other farm duties, at least half the time, and possibly two thirds, the ox-team population represents a net total of say 700,000 vehicle units on the local, and occasionally on the main roads. As a consequence of this number, as compared to the total motor vehicles in use at present, and the wide disparity in their respective speeds and behavior in traffic, the ox cart is important as a traffic factor in rural areas and smaller communities.

The vehicle is important for another reason as well. On narrow pavement surfaces, such as exist now in all parts of Burma, a motor vehicle which overtakes a cart going in the same direction or meets an approaching one, causes the animal-drawn vehicle to turn off the pavement surface and on to the shoulder. This process, since almost all of the carts have narrow band steel tires, is destructive to the edges of pavements, especially bituminous surfaces. The condition is especially damaging in recent times, for the lack of adequate highway maintenance has permitted the surface of the shoulder to become depressed, adjacent to the edge of the roadway surface. This step, which is bumped over twice each time a cart leaves the paved way and then returns to it, is sometimes six to eight inches in height, and hardly ever, except immediately after the visit of the road gang, less than two inches. A great deal of the raveling and ragged-toothed edges of the present pavements is due to this cause.

As examples of the destructive effect of "turning off," see Plate 1, in Section C of this chapter.

In the case of gravel and earth roads, the result of the turning-off process by carts is to produce ruts in the road surface. These are dangerous to other traffic and costly to eliminate by maintenance.

The problem has several solutions:

(*a*) The development of a pneumatic-tired cart, to avoid damage to the pavement edges, and to reduce rutting on gravel and earth roads.

(*b*) The insistence, by the traffic regulatory agencies, that the present narrow (in some cases as little as one-inch width) steel-band tires be replaced by wider tires, to reduce the high unit pressure on the pavement immediately under the tire as it goes off or comes on to the pavement surface, and to reduce the effect of rutting on gravel and earth roads.

(*c*) To force the carts to use only the shoulders, or other berm roads.

(*d*) To reconstruct the road surfaces with sufficient width to eliminate, or at least drastically reduce, the "turning-off" process. This scheme will only be completely successful if it is accompanied by a major improvement in the quality of shoulder maintenance, for the surfaces immediately adjacent to the pavement must be well kept, and at the same elevation as the surface of the latter.

(*e*) To surface the shoulders, to provide on them a surface of sufficient strength to carry the cart loads, even with narrow tires.

It is the consultant's view that a combination of solutions (*d*) and (*e*) is the preferable answer to the problem. Strong recommendations as to road maintenance and especially that on shoulders, are made in this Report. The recommendations for roadway sections on the national roads, district roads and farm-to-market roads, as more fully described elsewhere and shown on Plates 6–9, provide treated shoulder surfaces, of sufficient width to accommodate mixed traffic with a minimum necessity to leave the pavement.

In several countries, and especially in the Phillipines, the governments have been fairly successful in obtaining the use of wider cart tires by having wheels with such tires made by prison labor and sold to the cart owners at a very nominal price. Various methods were used to popularize the public interest and participation in the program, but the most important factor appears to have been the low price at which the equipment was made available. It may well be that with present conditions in Burma, a parallel idea would have fruitful results, and that the road maintenance costs would be sufficiently reduced, over a reasonable period, to make the program economically feasible.

Highway grades, too, have to be held to a very low figure in areas where the bullock carts and coolie carts are used. It has been found in India, for example, that a gradient of 1 : 40 (which is 2½%) is about the maximum that can be negotiated by either of these vehicles with the weight of loads that are commonly carried. In recent years, several major structures and highway approaches have been designed and constructed under this limitation.

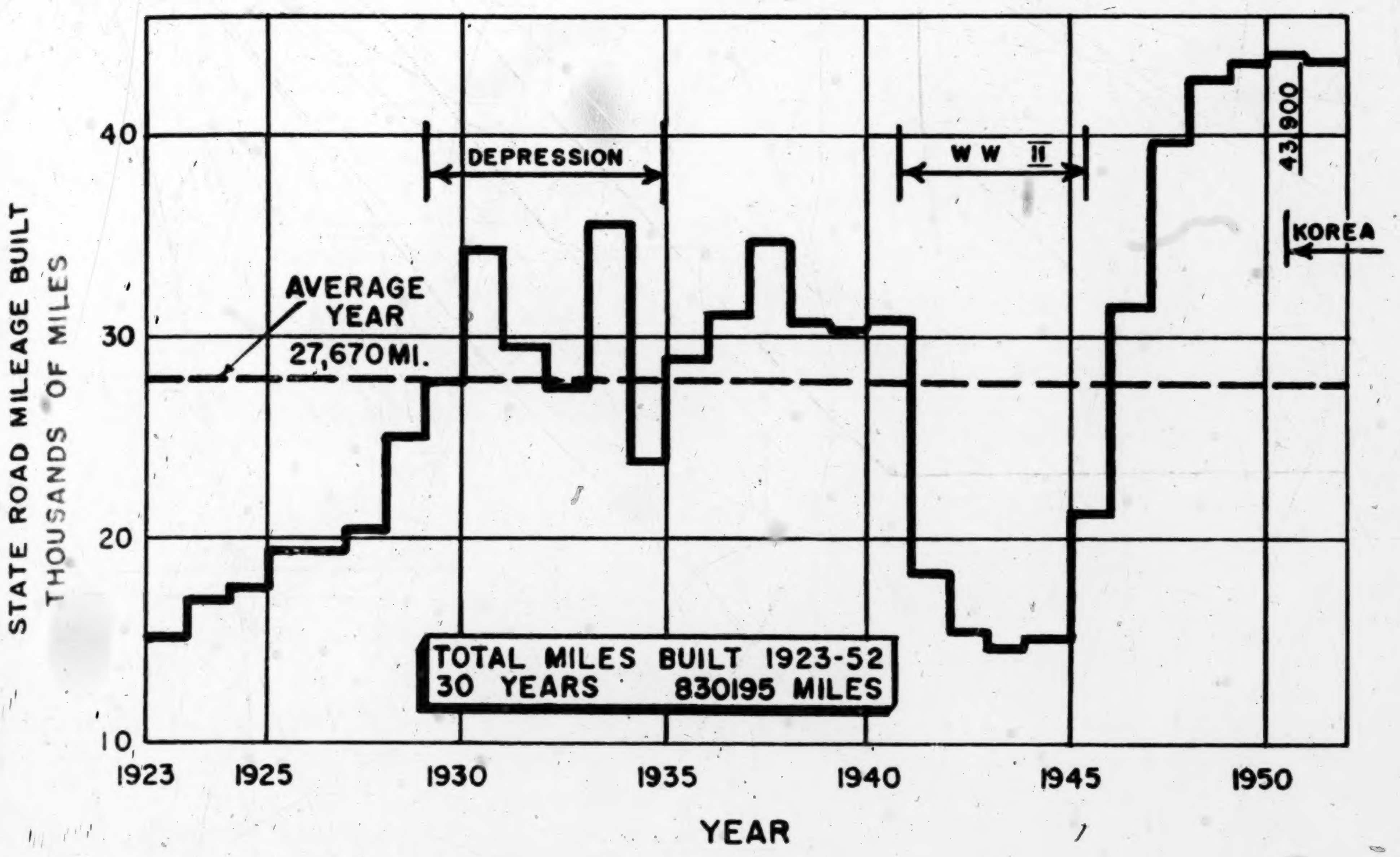
E. COMPARISONS WITH OTHER HIGHWAY SYSTEMS

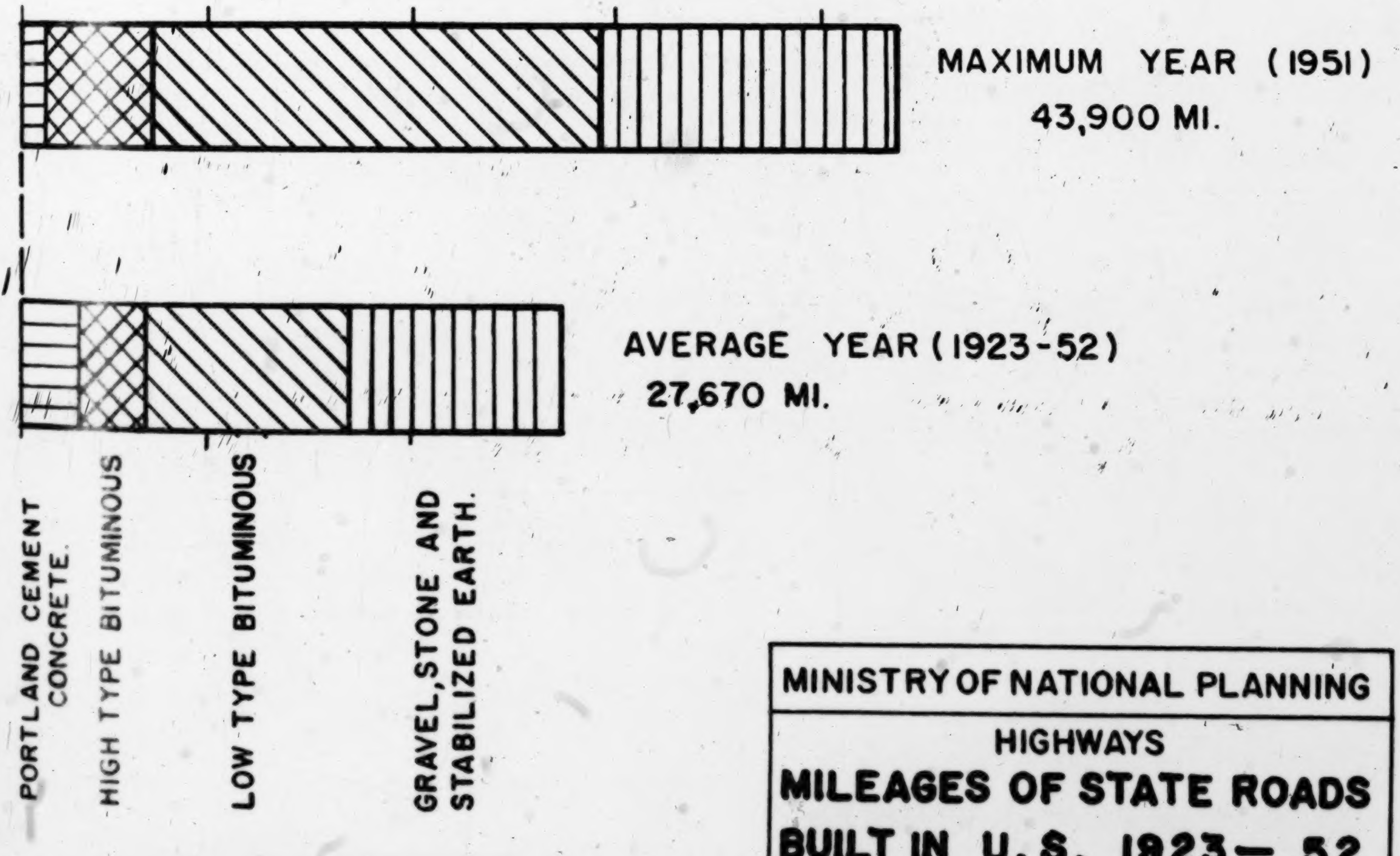
1. GENERAL COMPARISONS

Burma has been previously compared with other countries as to motor vehicle registration density (Table XVI–4). It was indicated that there was in Burma in 1952 one vehicle for each 800 persons, as compared to one for each 350 for several other countries and one for each 3·2 persons in the United States. However, the number of vehicles per capita is not the sole measure of the adequacy or inadequacy of motor transport. The stage of development of the country, its size, physical characteristics, climatology, topography, essential industries and agriculture, and other transport facilities, and many other factors have a bearing on the general problem.

To illustrate the influence of these factors, a general discussion of their effects in other countries and in several states of the United States is presented in the remainder of this section. The states are hereafter referred to as "comparative states," and a brief description is given of each. The statistical data is later set down in tables applicable to the several aspects of the study.

The total road construction program, as carried out year after year in the United States, although varying in extent somewhat in times of economic upheaval, has been on a constantly increasing scale. The magnitude of the increase is shown in Plate 4. In the past thirty years a total of 830,195 miles of state roads have been built in the United States. In the average year, more than 27,000 miles of highway were constructed, and in 1951, the maximum year, the figure was 43,900





TYPE OF CONSTRUCTION

MINISTRY OF NATIONAL PLANNING

HIGHWAYS

MILEAGES OF STATE ROADS
BUILT IN U.S. 1923— 52

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK. RANGOON

DR BY. EJP DATE PLATE
CK BY. KBW JUNE 53. NO. 4.

miles. Also shown on the plate are the pavement types for an average year and for 1951.

a. Comparative States

Iowa. This is a midwestern state, predominantly agricultural, although there is also some coal mining. The state road system dates from about 1900, and the Highway Commission was established in 1913.

Kansas. This is also a farming state. The earliest transport was by water, on the Missouri. This was replaced by rail transport, and then by the motor vehicle. There were 9,000 miles of improved roads in the state in 1937, and this has since grown to more than 37,000.

Ohio. This is a farm-industrial state. Early traffic used the Ohio River, and the earliest transcontinental highway, the National Pike, traversed southern Ohio.

California. Since the start of World War II, this state, once predominantly agricultural, has grown rapidly in the direction of light industry. Highway transport began to develop rapidly in 1900, and the Highway Commission was instituted in 1909. The state has been very progressive in the development of good highway construction and maintenance techniques.

South Dakota. This is a small farming state. The state road system came into being about 1905, and since then almost all the prairie trails have been converted to motor highways.

To indicate the degree to which the farmer in the United States has convenient access to communities other than his own by reason of being on or close to all-weather roads, consider the data in Table XVI–8.

TABLE XVI – 8

DISTANCE FROM FARMS TO ALL-WEATHER ROADS, U.S.

(per cent of all farms)

State	*Distance from Farm to All-weather Road, miles*					
	0–0·2	*0·2–0·3*	*0·5–0·9*	*1–1·9*	*2·0–5·0*	*Over 5 Miles*
Iowa	66	9	3·5	10·5	6	1
Kansas	47	10	3	16	14	6
Ohio	82	5	1·5	4·5	2	0·3
California	85	3·5	1	2·5	1·5	0·7
South Dakota	40	12	4	17	13	11
Whole U.S.	64·4	8	2·2	9·1	7·7	3·5

In 1945, two thirds of all farms in the United States were on all-weather roads (passable at all times and seasons), and in the northeast and Pacific coast states, the figure was four fifths.

The increasing access which the rural citizen has to the developing road network is also well shown on Plate 5, US Rural Road Mileage, 1904–53. Both the surfaced mileage and the non-surfaced mileage rose rapidly during the 50-year period, the latter at an especially high rate during the ten years preceding World War II. The proportion of the total rural mileage which is surfaced has also climbed steadily, and at the present time 57% of the total rural mileage is paved.

b. Comparative Countries

To establish the current nature and probable future of motor transport in Burma in the foreseeable future, the similarities with other countries, both in Asia and elsewhere, were scrutinized. While the data from several of these is incomplete, the attempt was made to cast it in a form to be useful in the studies of the highway trends. There follow some significant figures and comments on highway work in several selected countries.

Turkey. Turkey had a national income in 1950 of TL7,162 million (TL1 = \$0.36 = K1.72), almost half of which was derived from agriculture, forestry and fishing. In 1950, the total highway budget was TL82·5 million, as follows:

Revenues	TL53 million
General Budget	19·5
Loans	10
	TL82·5 million

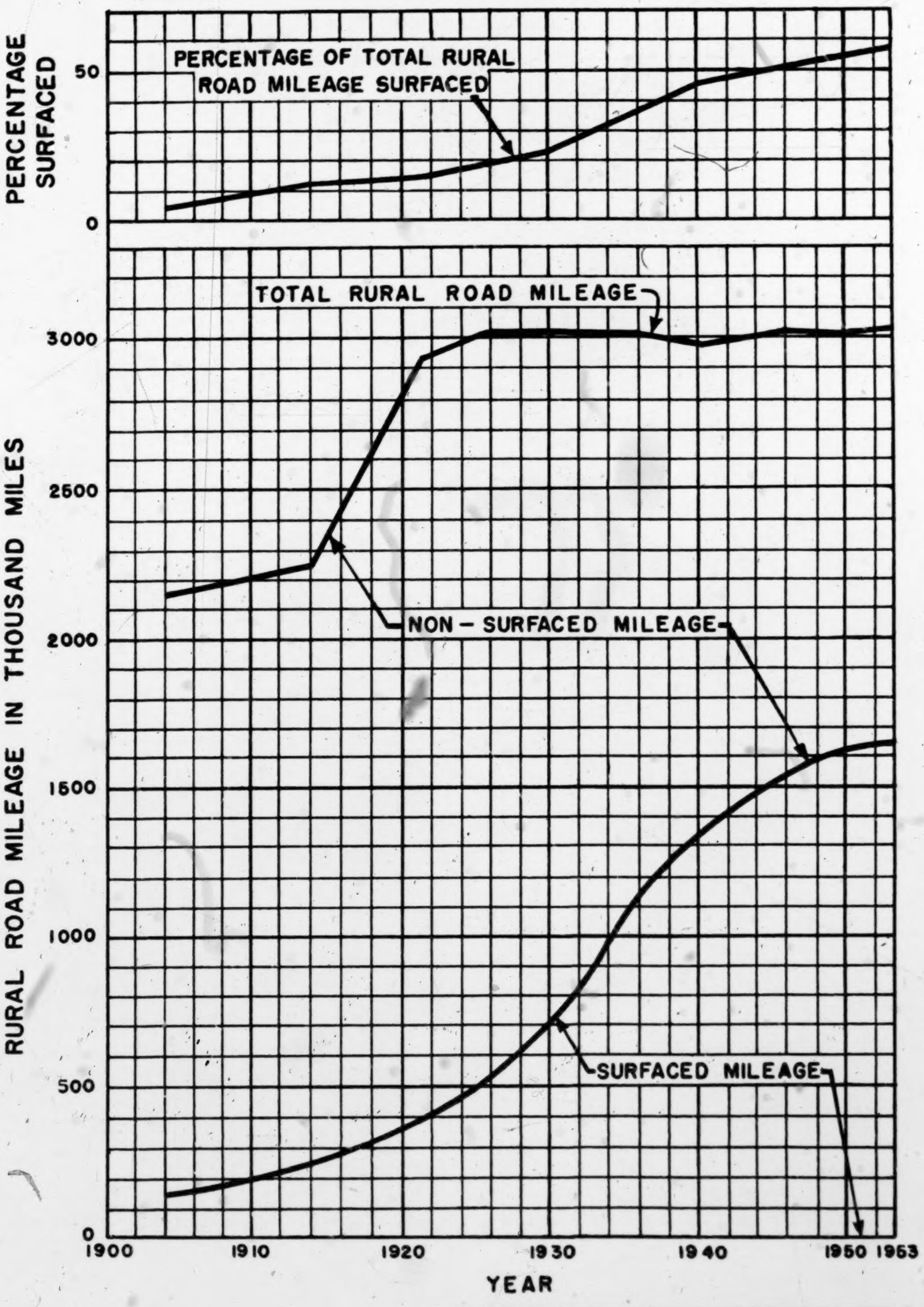
This income was expended as follows:

Provincial Highways	TL7 million
Trunk-line Construction	50
Maintenance and Administration	25·5
	TL82·5 million

Guatemala. In 1950, the national income was Q50 million (Q1 = \$1 = K4.75), and almost 60% was derived from agriculture, fishing and forestry.

The net highway budget of Q4·03 million, 8% of the national income, was not sufficient for the proper maintenance and restoration of existing roads, and more funds were made available by the addition of Q1·43 million from the receipts of the coffee tax. In the original budget Q1·8 million had been allotted for maintenance, including shops and incidentals, a total of \$525 per mile of highway.

Ceylon. In 1951–52, the expenditures for replacement and reconstruction totaled Rs.21·8 million, and the bridge and road maintenance was Rs.17·2 million,



MINISTRY OF NATIONAL PLANNING

HIGHWAYS

U.S. RURAL ROAD MILEAGE, 1904-53

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY EJP	DATE	PLATE
CK. BY. KBW	MAY 53	NO. 5

TABLE XVI – 9A

POPULATION, LAND AREAS, HIGHWAY MILEAGES

State or Country	*Population*	*Total Land Area (sq. mi.)*	*Per cent Cultivated*	*Present Highways, miles*			
				Metaled and Surfaced	*Metaled Only*	*Dirt Roads*	*Total*
Burma	19,250,000	261,749	10	2,080	3,527	2,449	8,056
Entire U.S.	150,555,592	2,977,128	19	1,616,557	1,319,495	66,457	3,002,509
Iowa	2,621,073	56,280	60	66,518	34,769	22	101,309
Kansas	1,905,299	82,276	43	37,415	91,749	337	129,601
Ohio	7,946,627	41,222	41	76,112	9,383	8	88,503
California	10,586,223	1,569,213	8	58,634	38,587	269	97,690
So. Dakota	652,740	77,047	33	31,079	64,079	174	95,332
Iraq	4,800,000	168,400	Not known	1,550	320	3,130	5,000
Ceylon	7,550,000	25,000	20	11,100		8,000	19,100
Guatemala	2,787,000	45,452	6·5	—	—	—	3,400*
Turkey	20,900,000	299,000	Not known				
(National roads)				8,000†	2,700	2,700	13,400
(Provincial roads)				—	—	—	13,500

Note: For Vehicle Registration, see Table XVI–4.
* National and departmental roads.
† Includes 2,850 miles of ruined macadam.

making a total of Rs.39 million. These funds were expended on a national system 11,095 miles in length. This represents only Rs.1,550 per mile per year.

Iraq. In Iraq, the provincial governments and the towns control the secondary roads and urban streets. For the national system, administered by the public works department, the maintenance costs are allocated on the basis of the Ministry's budget. The unit cost per year was ID40 per km. (ID 1 = \$2.80 = K13.3) or \$180 per mile per year, or K850 per mile per year.

2. STATISTICAL DATA, DENSITIES

There are presented here two tables, from which comparisons can be made to evaluate the current state of development of Burma's highway system. The tables are XVI–9A, Population, Land Areas, Highway Mileages; and XVI–9B, Highways—Land Areas. From these tables, the following observations can be made:

(*a*) Burma is proportionately less developed, agriculturally, than any of the comparative American states, except California, which has a high proportion of rugged mountainous area. However, the cultivation of individual holdings here is much more intense than for the other countries or states listed.

(*b*) In Table XVI–9A, the comparison of types of pavement and pavement surface is of interest in view of the differing degree of development of the several states and countries. The high percentage of surfaced road for the older systems is significant, in that this is probably the direction into which the pressure of traffic will force the highway administration in planning for the principal Union routes, I and II, and later the others, III–VIII.

TABLE XVI – 9B

HIGHWAYS—LAND AREAS COMPARATIVE STATES AND COUNTRIES

State or Country	*Total Mileage, Roads and Streets*		*Miles of Roads and Streets per sq. mile Land Area*	
	Surfaced	*Total*	*Surfaced*	*Total*
Burma	2,080	8,056	0·008	0·031
Entire U.S.	1,864,405	3,321,472	0·63	1·12
Iowa	74,209	111,526	1·33	1·99
Kansas	42,442	136,844	0·52	1·67
Ohio	91,346	104,821	2·22	2·55
California	75,266	117,022	0·48	0·75
So. Dakota	32,615	97,713	0·43	1·28
Iraq	1,550	3,450	0·009	0·02
Ceylon	—	19,100	—	0·77
Guatemala	—	3,400	—	0·08
Turkey	8,000	26,900	0·03	0·09

Notes: For vehicle registration, 1950, see Table XVI–4.
For land areas, see Table XVI–9A.

TABLE XVI – 10

OUTLAYS OF STATE REVENUES STATE-ADMINISTERED HIGHWAYS, 1950

(in thousands of dollars)

State	*Capital Outlay, Roads and Bridges*			*Maintenance Outlay*			*General Outlays*				*Retirement of Obligations*	*Total Disbursement*
	Primary (Rural)	*Urban Extensions*	*Total*	*Primary (Rural)*	*Urban Extensions*	*Total*	*Admin. Engrg.*	*Highway Police*	*Interest*	*Subtotal*		
Iowa	12,512	4,604	17,116	7,862	107	7,969	805	963	58	26,911	4,515	31,426
Kansas	20,421	1,266	21,687	8,473	404	8,877	2,029	712	—	33,305	998	34,303
Ohio	31,709	6,871	38,580	27,936	167	28,328	8,033	2,629	6	77,576	290	77,866
California	52,335	34,155	86,490	16,504	4,413	20,917	6,880	8,692	1,666	124,645	12,321	136,966
So. Dakota	7,378	505	7,883	4,307	—	4,307	585	162	—	12,937	—	12,937
Whole U.S.	922,237	302,421	1,533,859*	397,003	33,608	501,487	109,841	77,612	60,714	2,283,513	199,407	2,482,920

* Includes 132,971 (park, etc., roads) and 176,230 (secondary roads under state control).

(*c*) It is from Table XVI–9B that the lack of highway facilities in Burma really appears. For the average of all of the United States there are 0·63 miles of surfaced street or highway per square mile of land area. For Burma, the figure is one fortieth as great. For total pavements (both surfaced and unsurfaced), the story is only slightly better, the ratio being one thirty-sixth. Only Iraq has a comparable figure, as shown in the last two columns of the table.

3. STATE ADMINISTERED HIGHWAYS

In Section M of this chapter, the sources of the state revenues for highway purposes in the United States are tabulated. The fuel tax totals almost half of the states' highway income, and vehicle licence fees total a quarter of the whole.

In Table XVI–10, the disbursement of these funds for state-administered highways is shown by basic categories. The values in the table are listed in thousands of dollars, and represent the capital outlays for roads and bridges, the maintenance outlay, and the general outlays for state-administered funds, in 1950.

It will be noted that for both Kansas and South Dakota, almost 95% of the capital outlay was on the primary system. The counterpart proportion was 60% for the entire United States. Likewise, almost 80% of the outlay for maintenance went for service to the primary system.

The total outlays of state revenues for state administered highways, for the total of all of the states making up the United States may be summarized, from Table XVI–10, as follows:

	Thousands of Dollars	*Per cent of Whole*
Capital Outlay	1,533,859	62·0
Maintenance	501,487	20·0
Administration, Engineering	109,841	4·5
Highway Police	77,612	3·0
Interest	60,714	2·5
Subtotal, Current Expenses	2,283,513	92·0
Debt Retirement	199,407	8·0
Total Disbursements to State-administered Highways	2,482,920	100·0

During 1949, also, local governmental units expended on the streets of the cities, towns and villages of the United States a total of more than twenty million dollars, divided as follows:

	Expenditures (in thousands of dollars)
Right of Way	9,986
Construction	9,376
Maintenance	1,271
Total	20,633

In the same year, the spending by local urban units on streets of cities and towns was, for the entire United States, more than seven hundred million dollars, as follows:

Right of Way	13,062
Construction	301,062
Maintenance	341,530
Miscellaneous	53,169
Total	708,823

4. MAGNITUDE OF PROGRAM

During 1950, the magnitude of the operations carried out by the state highway departments was as shown in Table XVI–11. These were contracts awarded during the year, with and without federal funds involved in the financing. The work had to be planned; the contract drawings, specifications and estimates had to be prepared; and the work had to be supervised by the several departments.

TABLE XVI – 11

CONSTRUCTION CONTRACTS AWARDED BY STATE HIGHWAY DEPARTMENTS, 1950

State	*Projects with, or Partly with, Federal Funds*			*Projects without Federal Funds*		
	No. of Projects	*Cost ($1,000)*	*Miles*	*No. of Projects*	*Cost ($1,000)*	*Miles*
Iowa	407	22,260	1,257	682	10,903	2,399
Kansas	345	17,400	1,754	198	4,948	923
Ohio	231	48,676	470	298	14,408	2,141
California	113	36,139	381	253	25,407	528
South Dakota	187	11,988	1,194	9	1,293	98
Total US	5,787	820,659	23,429	7,674	694,045	32,038

There were in progress during the year a total of almost 13,500 projects, involving the expenditure of a billion and a half dollars and resulting in the construction and improvement of some 55,000 miles of highway in the United States.

Likewise, the federal aid projects completed during the year, on primary and secondary rural and urban highways, are shown in Table XVI–12.

5. TYPES OF CONSTRUCTION

Various types of highway construction are used in each of the states in the United States. Engineering comparisons are constantly being made to determine the most suitable and economic surface to use in any given location and set of circumstances, and alternate bids on different types are sometimes called for to verify the comparisons. Also, the price of local materials often has a determining influence.

Table XVI–13 brings the picture into focus for the whole United States. In it are shown the mileages of various types of pavement at the beginning of 1950, and the mileage changes resulting from new construction and replacement during the year.

6. SOURCES OF DATA

In this section, and in the part of the Report relating to highways, material and factual data, as well as comparisons and general information, have been drawn from many sources, the more important of which are listed below:

Burma

(**a**) Buildings and Roads Department, Ministry of Public Works, data on operations of Department, its administrative organization, programs, budgets, costs, etc., from prewar and postwar reports of the Department; records of the Department; Highway Act of 1907 and notifications; and numerous consultations with officers and staff of the Department and executive and district engineers in the central office and district offices throughout Burma.

(**b**) Motor vehicle registration and related data from Office of Motor Vehicle Registration, Rangoon.

(**c**) Population figures and growth rates (in part)

TABLE XVI – 12

US FEDERAL AID HIGHWAY PROJECTS COMPLETED, 1950

(costs in thousands of dollars)

State	*Total*		*Rural Highways*				*Urban Highways*	
			Primary		*Secondary*			
	Miles	*Cost*	*Miles*	*Cost*	*Miles*	*Cost*	*Miles*	*Cost*
Iowa	1,164·8	24,328	291·6	13,400	864·5	8,571	8·7	2,357
Kansas	1,980·1	23,386	427·5	13,834	1,537·1	6,963	15·5	2,569
Ohio	209·7	28,802	66·9	14,668	133·9	4,695	8·9	9,439
California	223·1	26,149	64·1	12,005	145·2	7,845	13·8	6,299
South Dakota	823·1	8,655	283·6	4,358	538·5	4,081	1·0	216
Entire US	19,876	753,199	5,145·1	307,680	14,185·5	232,291	545·4	213,228

TABLE XVI – 13

MILEAGE CHANGES ON STATE SYSTEMS, UNITED STATES HIGHWAYS, 1950

Type, etc.	Total, Entire US on January 1, 1950 (miles)		Constructed During 1950 (miles)
(*a*) On Primary Rural State Highways			
Primitive	669		—
Unimproved	3,409		—
Graded and Drained	9,114		608
		13,192	
Soil Surfaced	4,400		112
Slag, Gravel or Stone	43,351		3,983
Bitum. Surf. Treated	76,516		7,938
Mixed Bitum—Non-rigid Base	38,069		2,914
,, ,, —Rigid Base	44,434		3,901
Bitum. Penetr.—Non-rigid	9,995		236
,, ,, —Rigid	13,145		346
Bituminous Concrete	35,801		3,804
Cement Concrete	77,921		1,019
Brick and Block	826		—
		344,458	
Subtotal, (*a*)		357,650	24,870*
(*b*) Secondary Roads under State Control			
Primitive	1,697		—
Unimproved	29,720		—
Graded and Drained	28,872		1,147
		60,289	
Soil Surfaced	38,566		2,143
Slag, Gravel or Stone	46,004		5,199
Bitum. Surf. Treated	44,103		5,606
Mixed Bitum.—Non-rigid Base	1,967		241
,, ,, —Rigid Base	1,624		404
Mixed Penetr.—Non-rigid	685		110
,, ,, —Rigid	8,301		690
Bituminous Concrete	2,183		2,085
Cement Concrete	1,973		29
Brick and Block	138		—
		145,544	
Subtotal, (*b*)		205,833	17,654†
(*c*) Urban Extensions of State Systems			
Primitive	26		—
Unimproved	444		—
Graded and Drained	354		29
		824	
Soil Surfaced	371		19
Slag, Gravel or Stone	1,232		91
Bitum. Surf. Treated	4,985		372
Mixed Bitum.—Non-rigid Base	2,374		138
,, ,, —Rigid Base	2,337		232
Bitum. Penetr.—Non-rigid	627		—
,, ,, —Rigid	1,209		38
Bituminous Concrete	8,682		661
Cement Concrete	11,003		160
Brick and Block	1,572		1
		34,392	
Subtotal, (*c*)		35,216	1,741‡
Summary			
(*a*) Primary		357,650	24,870
(*b*) Secondary		205,833	17,654
(*c*) Urban		35,216	1,741
Total, entire United States for 1950		598,699	44,265§

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* Of this, 23,317 is mileage of former types replaced.

† Of this, 17,536 ,, ,, ,, ,, ,, ,,

‡ Of this, 1,574 is mileage of former types replaced.

§ Of this, 42,427 is mileage of former types surfaced.

from Office of the Commissioner of the Census, Rangoon.

(d) "Report to Government of Burma on Low Cost Roads," F. L. D. Wooltorton, Public Works Department, 1948.

(e) "The Motor Roads of Burma," 4th Edition (1948), published by Burmah Oil Co. Ltd., Rangoon.

(f) "Burma Handbook," 1945, published by Government of Burma at Simla.

Other Sources

(a) From US Bureau of Public Roads:

(1) "Highway Statistics," Summary to 1945, and 1950.

(2) "Standard Specifications for Highway Bridges."

(3) "Standard Specifications for Testing and Materials."

(b) From Committee on Inter-Regional Highways, US: Report to the President and Congress, 1944. This contains much data on long-range regional highway planning, basic standards for design of roadways and structures in both rural and urban areas.

(c) United States Census of Agriculture, 1945, for data on farms, farm income and land areas.

(d) From Highway Research Board, U.S.:

(1) Bulletin 13, "Appraisal of Terrain Conditions for Highway Engineering Purposes," 1948.

(2) July 1951 Abstracts, Maintenance Costs.

(e) Soils investigations and testing:

(1) American Society for Testing Materials, Philadelphia, Pa, "Procedure for Testing Soils."

(2) US Bureau of Public Roads: Many reports in "Public Roads," various issues, on general and detailed aspects of the problem, including research on soil constants, soil road surfaces, pressures on culvert structures, subgrade surveys and studies, non-rigid pavements, drainage of sub-grades, and others.

(f) "American Highway Practice," by Dr. L. I. Hewes of US Bureau of Public Roads, John Wiley and Sons, 1949.

(g) "Highway Maintenance Manual," Division of Highways, State of California, US.

(h) "Organization Manual," Ohio Department of Highways, US, and Sixth Annual Report (1953), showing administrative structure of Division of Highways, State of California, US.

(i) World Bank Reports on Ceylon (1953), Guatemala (1951), Iraq (1950) and Turkey (1951). Published by Johns Hopkins Press, Baltimore, Maryland, US.

(j) "Regulatory Administration," Geo. A. Graham and Henry Reining, Jr., Editors. Published by John Wiley and Sons, 1943.

(k) "Automobile Facts and Figures," and "Truck Facts and Figures," published annually by Automobile Manufacturers Association, US general data on vehicles registration, road and street mileages, highway costs and financing.

(l) Associated General Contractors, U.S.: Paper on the "Influence of Modern Equipment on Highway Construction," 1952, a complete historical review of the invention and development of modern mechanical equipment for highway construction, and the effect of its use on prices, productivity and the industry.

F. DESIGN REQUIREMENTS

1. GENERAL CONSIDERATIONS

As with all road systems, the one in Burma suffers from having been built in segments, each of which was presumably modified from the last construction to meet the current requirements of good design practice. As a result, the design standards are different on different parts of the system, and even on different portions of the same road. These inequities and peculiarities should be removed whenever opportunity permits in order that the operating and maintenance conditions shall be as nearly uniform and to as high a standard as possible.

As a motorist drives along a through highway he should not be confronted with frequent and unreasonable changes in pavement width, with alternately wide and narrow structures, and with variable shoulder widths and treatments. Also the standards for horizontal curvature and for sight distance, and especially their combination under unusual conditions, need to be such that the vehicle can be driven at a fairly constant speed, and with a feeling of confidence on the part of the operator. Likewise, the grades should be such as to produce safe and feasible operating speeds, with no undue strain on the vehicle, and this is especially true for the use of heavy trucks in mountain areas where the operating speeds are also likely to be hampered by alignment restriction due to topography.

The design standards to be adopted and used for the rehabilitation program have to be developed concurrently with the basic requirements which should be adopted for all new construction under the long-range program for highway improvement. The latter standards should be of as high quality as the economics of the program will permit, and there should not be any compromises with basic requirements.

Very serious consideration, too, should be given to fashioning the details of the roadway and shoulder section for the Union and district road system to facilitate the use of modern maintenance equipment in order that the "housekeeping" on the reconstructed and new sections of the highways may be of the best quality, and economic as well. Likewise, the drainage details should be adequate, as simple as possible, and also susceptible to good maintenance.

In general, the design standards now being used by the Department are basically sound but need modification to be adapted to good modern practice. Compromises have been made in the past, in most cases to solve some local alignment, grade or property acquisition problems. The reconstruction offers a good opportunity to correct a number of these situations at the time that other construction operations are being carried on in the immediate locality.

The standards now established, though not always adhered to in adverse circumstances, are:

(a) Design speed: 30 m.p.h. With the sharp curves which now exist in a number of places on main roads, this speed could not be achieved.

(b) Sight distance: 800 ft. minimum, though there are a number of vertical curves on various roads of the system that are sharp enough to yield only 400–450 ft., and in a few instances 350 ft., or slightly more.

(c) Limiting grade: 3·33% (= 1 : 30). Many grades are much steeper than this, especially in upper Burma. In some instances the grade is too steep for only short stretches.

(d) Side slopes: 1½ to 1 and 2 to 1. It was noticed in the inspection trips that the cut slopes needed to be cut back at a great many locations, to prevent the blocking of the drainage ditches by slope earth.

(e) Crown of road: 1 : 60 (one fifth inch per foot, transverse to the centerline) is striven for, but not always obtained; 1 : 40 is observed to have been used in many cases.

(f) It is understood that in prewar times it was the practice to grass the slopes at bridge abutments. This practice should be re-established at once, following the shaping up of the embankment contours.

The development of design standards for the farm-to-market road section, and geometrics is important from the viewpoint that the most important factor, other than construction cost, is inexpensive maintenance.

For the determination of roadway capacity the recommendations and definition for capacity offered by the Highway Research Board are applicable. The definition follows:

The practical capacity of a roadway has been defined as "the maximum number of vehicles that can pass a given point on a roadway or in a designated lane during one hour without the traffic density being so great as to cause unreasonable delay and hazard, or restrictions to the driver's freedom to maneuver under the prevailing roadway and traffic conditions." The distinction should be noted between *practical* capacity, which is qualified by the degree of convenience experienced, and *possible* capacity which is not related to convenience. The practical roadway capacity depends on a number of factors such as the traffic speeds, the proportion of commercial vehicles to total vehicles, lane widths, lateral clearances, shoulder conditions, alignment and grades. These factors were studied in detail in developing the criteria from which to establish the pavement widths for the recommended typical sections for the Union and district road systems.

2. CONCLUSIONS AND RECOMMENDATIONS

It is proposed that new basic cross-sections be established for the Union road system and the district road system. It is preferable to have a wider section for those portions of Routes I and II just north of Rangoon. It is therefore proposed that from Rangoon to Pegu on Route I, and from Taukkyan to Prome on Route II, the roadway be reconstructed to a minimum width of 20 ft. The remainder of Routes I and II should have a roadway width of 18 ft. The other Union Routes, Nos. III–VIII, are designed with a recommended pavement width of 16 ft., while the width for the district road system is established at 14 ft. The design for the proposed farm-to-market road section incorporates a 12-ft. surface width.

The sections were designed on the basis that the modern techniques of compaction with moisture control, using mechanical construction equipment, would be used.

Proposed details of the four sections are as shown on Plates 6, 7, 8 and 9. The basic characteristics and dimensions are shown in Table XVI–14, which follows:

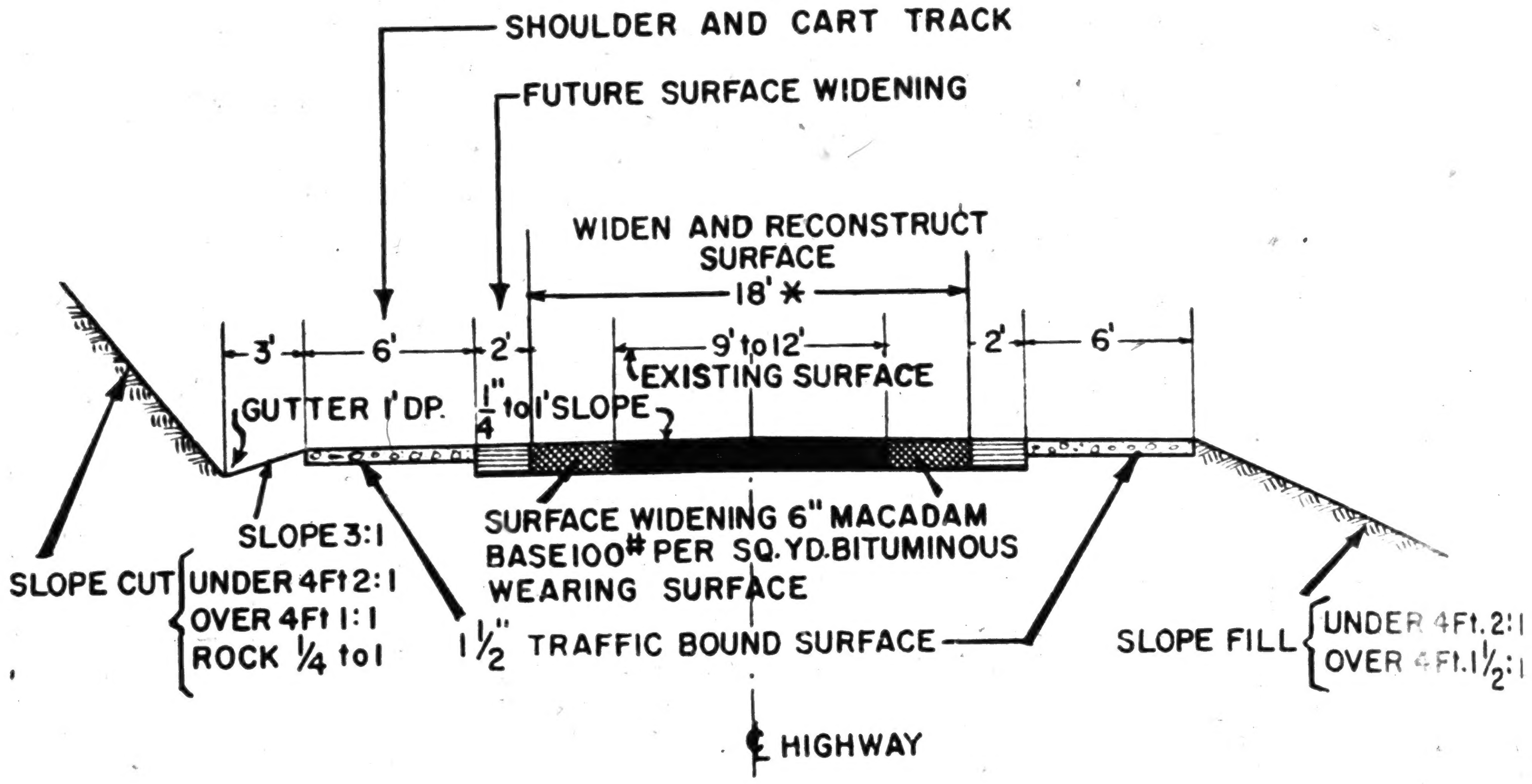
TABLE XVI – 14

RECOMMENDED PAVEMENT AND SHOULDER WIDTHS

	Width of Widened and Re-constructed Pavement	*Width of Shoulder*	*Total Platform Width*
Union Roads			
Route I, Rangoon to Pegu	20 ft. min.	6 ft.	32 ft. min.
Route I, remainder	18 ft.	6 ft.	30 ft.
Route II, Taukkyan to Prome	20 ft. min.	6 ft.	32 ft. min.
Route II, remainder	18 ft.	6 ft.	30 ft.
Routes III–VIII	16 ft.	6 ft.	28 ft.
District and Secondary Roads	14 ft.	6 ft.	26 ft.
Farm-to-market Roads	12 ft.	4 ft.	20 ft.

Notes: (*a*) Routes I and II, south of Pegu and Prome, respectively, are planned for future widening, as necessary with developing traffic, to an ultimate pavement width of 24 ft.

(*b*) Other portions of Routes I and II are similarly planned for an ultimate pavement width of 22 ft.


SHOULDER AND CART TRACK
FUTURE SURFACE WIDENING
WIDEN AND RECONSTRUCT SURFACE
18' *
3'
6'
2'
9' to 12'
2'
6'
EXISTING SURFACE
GUTTER 1' DP.
$\frac{1}{4}$" to 1' SLOPE
SURFACE WIDENING 6" MACADAM BASE 100# PER SQ. YD. BITUMINOUS WEARING SURFACE
SLOPE 3:1
SLOPE CUT
UNDER 4Ft 2:1
OVER 4Ft 1:1
ROCK 1/4 to 1
1 1/2" TRAFFIC BOUND SURFACE
SLOPE FILL
UNDER 4Ft. 2:1
OVER 4Ft. 1 1/2:1
℄ HIGHWAY

NOTES

* PAVEMENT SURFACE FOR WIDENED AND RECONSTRUCTED HIGHWAY TO HAVE 20 FT MINIMUM WIDTH FOR:-

ROUTE I - RANGOON TO PEGU

ROUTE II - TAUKKYAN TO PROME.

WIDEN SECTION ACCORDINGLY.

MODERN TECHNIQUES OF MOISTURE CONTROL AND COMPACTION TO BE USED FOR EMBANKMENT AND FOUNDATION CONSTRUCTION.

MINISTRY OF NATIONAL PLANNING

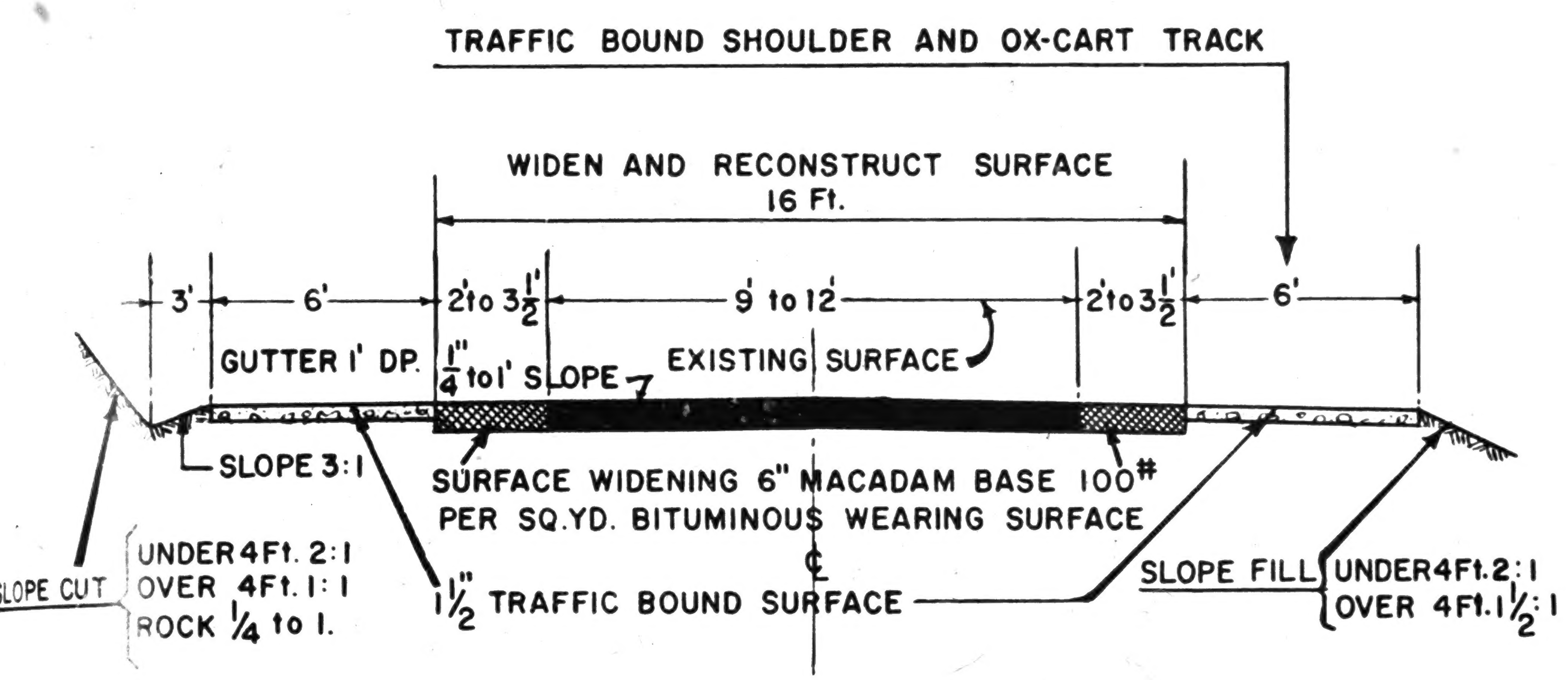
HIGHWAYS

TYPICAL SECTION

UNION ROADS I & II

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK. RANGOON

DR BY. E. J. P. DATE PLATE
CK BY. K. B. W. JULY. 53. NO. 6


TRAFFIC BOUND SHOULDER AND OX-CART TRACK
WIDEN AND RECONSTRUCT SURFACE
16 Ft.
3'
6'
2' to 3½'
9' to 12'
2' to 3½'
6'
GUTTER 1' DP.
¼" to 1' SLOPE
EXISTING SURFACE
SLOPE 3:1
SURFACE WIDENING 6" MACADAM BASE 100# PER SQ.YD. BITUMINOUS WEARING SURFACE
℄
LOPE CUT
UNDER 4Ft. 2:1
OVER 4Ft. 1:1
ROCK ¼ to 1.
1½" TRAFFIC BOUND SURFACE
SLOPE FILL
UNDER 4Ft. 2:1
OVER 4Ft. 1½:1

NOTE

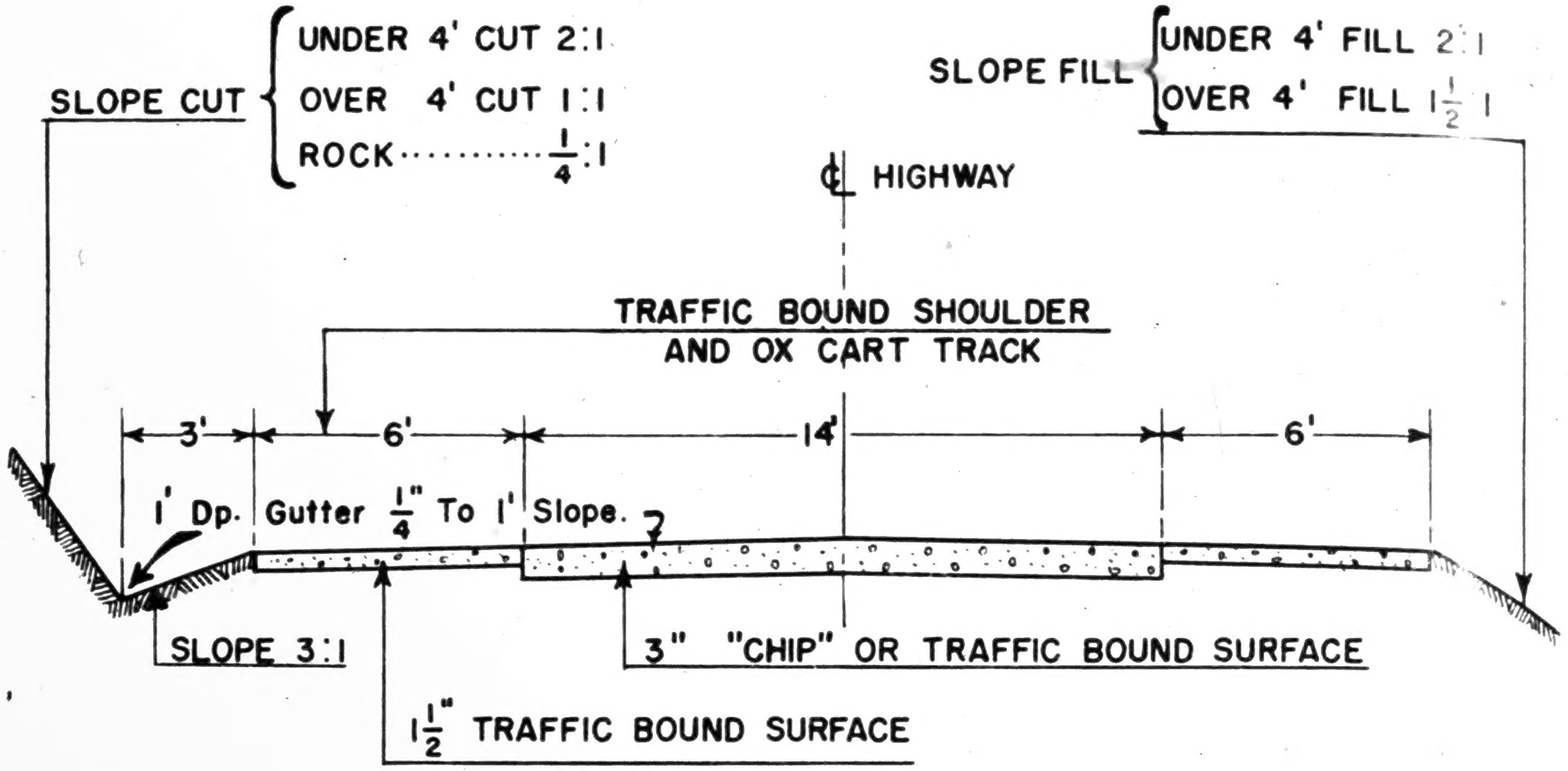
MODERN TECHNIQUES OF MOISTURE CONTROL AND COMPACTION TO BE USED FOR EMBANKMENT AND FOUNDATION CONSTRUCTION.

MINISTRY OF NATIONAL PLANNING

HIGHWAYS
TYPICAL SECTION
UNION ROADS III – VIII

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK. RANGOON

DR BY. E.J.P. DATE PLATE
CK BY. K.B.W JULY. 53. NO. 7


SLOPE CUT
UNDER 4' CUT 2:1
OVER 4' CUT 1:1
ROCK $\frac{1}{4}$:1
SLOPE FILL
UNDER 4' FILL 2:1
OVER 4' FILL 1$\frac{1}{2}$ 1
℄ HIGHWAY
TRAFFIC BOUND SHOULDER AND OX CART TRACK
3'
6'
14'
6'
1' Dp. Gutter $\frac{1}{4}$" To 1' Slope.
SLOPE 3:1
3" "CHIP" OR TRAFFIC BOUND SURFACE
1$\frac{1}{2}$" TRAFFIC BOUND SURFACE

NOTE:-

1) PORTIONS OF CERTAIN DISTRICT ROADS ARE ALREADY SURFACED, AND TO ESTABLISHED PAVEMENT WIDTHS GREATER THAN THE 14 FT. SHOWN FOR EXTENSIONS OF THESE HIGHWAYS, AND SURFACING, CONTINUE THE ESTABLISHED PAVEMENT AND SHOULDER SECTIONS, EXCEPT THAT THE LATTER SHALL NOT BE LESS THAN 6 FT. IN WIDTH.

2) MODERN TECHNIQUES OF MOISTURE CONTROL AND COMPACTION TO BE USED FOR FOUNDATION CONSTRUCTION.

3) ON CONSTRUCTION, PROVIDE STOCK PILES OF STONE, ONE MILE APART, CONTAINING 30 % OF THE TONNAGE INITIALLY PLACED ON ROAD SURFACE. THIS STONE TO BE USED BY MAINTENANCE FORCE TO REINFORCE WEAK SPOTS APPEARING IN SURFACE AFTER USE BY TRAFFIC.

SPECIFICATIONS FOR TRAFFIC BOUND STONE, SIZE 1$\frac{1}{2}$" DOWN TO DUST, "CRUSHER RUN" WITH DUST CONTENT RANGE TO BE 20% - 30%.

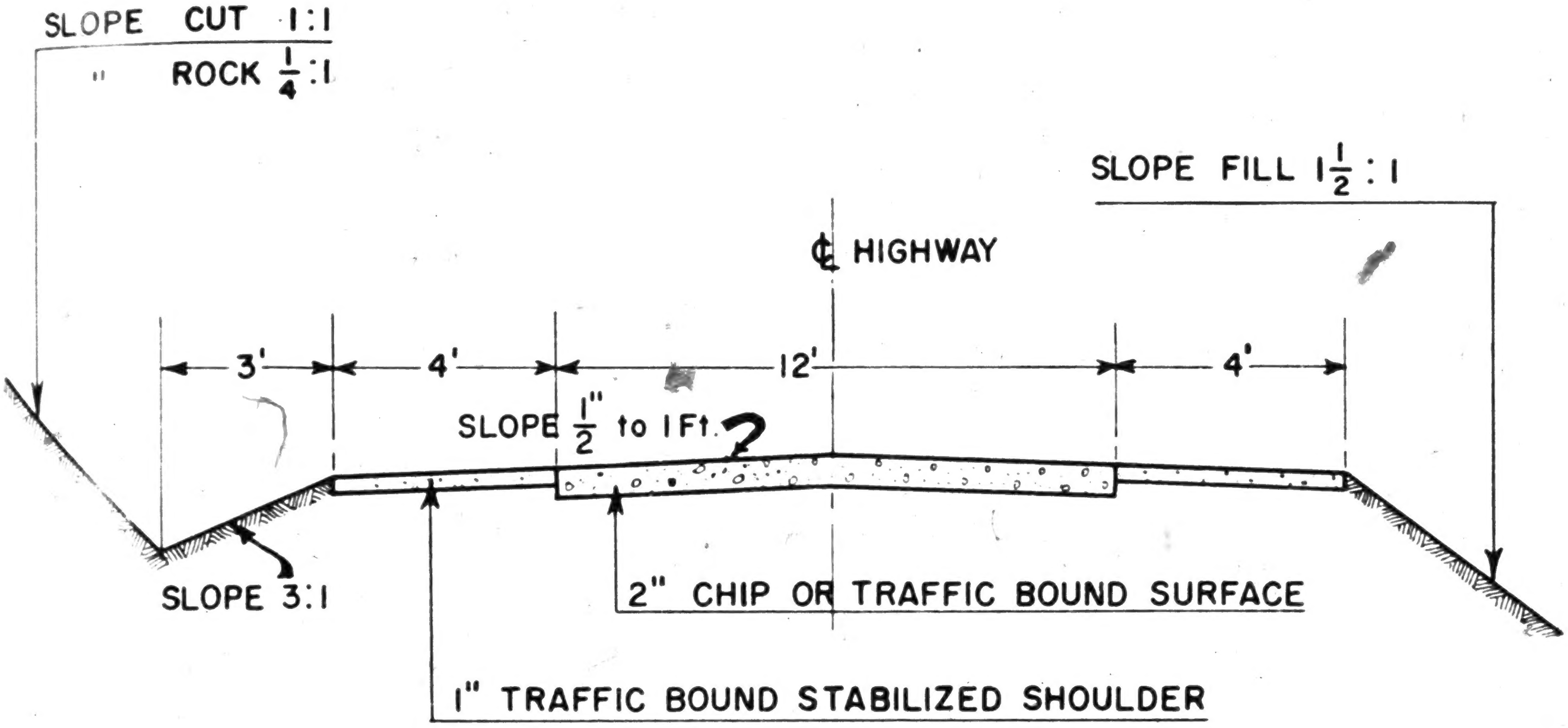
MINISTRY OF NATIONAL PLANNING

HIGHWAYS

TYPICAL SECTION
DISTRICT ROADS

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK. RANGOON

DR BY. E.J.P. DATE PLATE NO. 8
CK BY. K.B.W. JULY. 53.


SLOPE CUT 1:1
" ROCK $\frac{1}{4}$:1
SLOPE FILL $1\frac{1}{2}$:1
℄ HIGHWAY
3'
4'
12'
4'
SLOPE $\frac{1}{2}$" to 1 Ft.
SLOPE 3:1
2" CHIP OR TRAFFIC BOUND SURFACE
1" TRAFFIC BOUND STABILIZED SHOULDER

NOTE:-

ON CONSTRUCTION, PROVIDE STOCK PILES OF STONE, ONE MILE APART, CONTAINING 30 % OF THE TONNAGE PLACED ROAD SURFACE. THIS STONE TO BE USED BY MAINTENANCE FORCE TO REINFORCE WEAK SPOTS APPEARING IN SURFACE AFTER USE BY TRAFFIC.

SPECIFICATIONS FOR TRAFFIC BOUND STONE, SIZE $1\frac{1}{2}$" DOWN TO DUST "CRUSHER RUN", WITH DUST CONTENT RANGE TO BE 20 % – 30 %

MINISTRY OF NATIONAL PLANNING

HIGHWAYS

TYPICAL SECTION

FARM-TO-MARKET ROADS

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON

DR BY E.J.P. DATE PLATE NO. 9
CK BY K.B.W. JULY. 53

Based on the 1944 report on Inter-regional Highways* and on 1950 "Policies on Geometric Highway Design,"† it is proposed that the following standards be established for the rehabilitation program and all future designs for the Union, district and farm-to-market roads:

(**a**) Each part of the system as hereafter constructed or improved shall provide, or allow for the subsequent provision of facilities capable of serving safely a mixed traffic of passenger cars, motor buses and motor trucks, and that the volume of each of the constituent elements be that which is estimated to exist 20 years in the future from the date of construction.

(**b**) All roadways and structures shall provide for the passage and support of vehicles having a design load of 15 tons for the Union system, ten tons for the secondary and district roads, and five tons for the farm-to-market roads. Loadings shall be the corresponding H-loads, as established by the American Association of State Highway officials.

(**c**) Widths, heights, lengths and other load requirements of vehicles shall be as prescribed in Section N, "Proposed Highway Code," of this Report.

(**d**) Rural sections of the system shall be designed for the following safe travel by passenger vehicles:

Union System	60 miles per hour
District System	50 miles per hour
Farm-to-market System	40 miles per hour

(**e**) Urban sections shall be designed for the following safe travel by passenger vehicles.

Union System	50 miles per hour
District System	40 miles per hour
Urban System	40 miles per hour

(**f**) All road surfaces, pavements and structures on the system, when maintained with a reasonable expenditure of effort, shall be capable of supporting vehicles of the recommended weights without reduction in either weight or speed at any season of the year.

(**g**) On the rural sections, the maximum horizontal curvature for the several design speeds shall be as follows:

	Maximum	
	Absolute	*Preferable*
60 miles per hour	6°	5°
50 miles per hour	8°	7°
40 miles per hour	10°	9°

(**h**) On the rural sections, the no-passing sight distance for the various speeds shall be as follows:

	Minimum Distance
60 miles per hour	550 ft.
50 miles per hour	450 ft.
40 miles per hour	400 ft.

(**i**) Side slopes shall be as shown on the sections, in Plates 6–9 inclusive.

(**j**) The maximum desirable grades shall be as follows:

Union System	6·0%
District System	5·0%
Farm-to-market	6·0%

Grades shall in no case exceed the above values by more than 2%, and then only for short distances. In portions of the system such as approaches to structures where a long approach grade is appropriate, the grade shall not exceed 2½% in these situations where coolie carts and bullock carts are an appreciable part of the traffic volume.

(**k**) Right-of-way acquisition shall be on the basis of the traffic and road widening, if any, expected to occur during the 20-year period.

(**l**) The clear height of bridges, over the entire width of roadway, shall be not less than 14 ft.

(**m**) Structures preferably shall be of the deck type, to facilitate later widening.

(**n**) The necessary provisions shall be made for ox-cart travel, as shown on the typical cross-section.

(**o**) The urban standards shall conform as closely as possible to those outlined above for the rural sections, except as to the basic limitations already stated.

(**p**) Special-purpose roads, such as those to the mineral development areas and the timber areas, shall be of the minimum proper characteristics to meet the demands of the purpose, and shall generally conform, to the degree feasible, to the details in the recommended sections above. The grade limitation shall be established at a maximum of 7·5%.

G. CONSTRUCTION METHODS

1. TRADITIONAL METHODS

Except for a limited mileage in the urban sections of the more important routes, the surfaced highways of Burma are at present one-lane facilities. The methods used for their construction were the conventional techniques used for some years in Asia. For these tarred and metaled roads, the process consists of the placing of a base course of soling stone, 6 to 12 inches in thickness, with 4 to 4½ inches of compacted metal, having a limiting size of 2 or 2½ inches, as a wearing course. The wearing course is then bitumen-coated and is occasionally resurfaced with 1- to 2-inch graded stone, premixed with the asphaltic material. As an alternative method, the surface is sometimes prepared by applying 3 to 4 inches of bituminous bound macadam, using stone having a maximum size of either 1 inch or 1½ inches. The shoulders are of laterite, or of local stone where this is convenient.

Generally the surfaced roads consist of 10 to 12 inches of laterite soling, and the wearing course consists of laterite or other spalls. The surface is occasionally primed and sealed with bitumen, but this process has not been nearly as well nor as frequently used since the end of the war.

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* A publication of the 78th US Congress, 2nd Session.

† Established and issued by the American Association of State Highway Officials.

Both bitumen and road metals are very expensive in Burma, and the cost has been pushed to still higher levels in recent years by the depredations of insurgency and dacoits. Every possible effort should be made to introduce modern techniques to profit from the experience of others in the search for less expensive asphaltic pavements. Materials such as bitumen which come in bulk should be bought and processed in that manner, with suitable storage facilities in order to cheapen the unit price. Also there are many local deposits of good aggregate for highway purposes, and these, too, should be developed to the greatest degree.

The subgrade preparation needs to be of a higher quality, using modern techniques, in order that it shall be firm and behave properly in all conditions of weather. If this were to be accomplished, it would take only a relatively thin flexible pavement to carry the existing traffic. The saving in material, too, would aid in reducing the total pavement cost. The improvement of the subgrade construction will also necessitate the development of a soils laboratory, with the proper testing techniques, in order to take advantage of current compaction methods. All of these steps, however, are in the direction of mechanizing the highway construction procedures in Burma.

The use of modern methods and machines for this work is a "must," and it is of such vital importance to the whole program that it should be undertaken at the earliest possible moment.

There are some small quantities of used mechanical equipment in several districts. Most of it is old, material brought here during the war, and the problem of repair is becoming serious. Likewise, there is need for adequate training for operators and other technicians to enable them to properly use the equipment.

There are discussed in the succeeding section several modern bituminous paving techniques, with which very good results have been obtained elsewhere. It is suggested that one or more of these be studied and adapted to use in Burma. Again, however, good compaction of the subgrade is needed and this cannot be obtained at a reasonable cost without the use of mechanical road-building equipment. Especially in the use of "road mix," the proper inter-mixing of the aggregates and the bituminous material is vital, and this, too, requires modern equipment.

2. MODERN METHODS

In the United States, because of the great total mileages of highways and the very general use of motor vehicles of all types, the processes of highway construction have become more completely mechanized than in any other country.

Of all the processes that go into the building of a highway, that of earth moving has undergone the most mechanization. The moving of earth, sand and rock in large quantities is a necessary part of the construction of the road.

The ability of man, aided by cheap mechanical power, to produce more has freed him from drudgery and has given him a better life, more leisure, better earnings, the chance to have modern conveniences and comforts, and to improve his social conditions.

The changes and developments in road construction in the last half century have been revolutionary. Possibly the earliest improvement of major consequence was the road roller as a tool for compaction. The earliest rollers were manual, but steam had been applied as a motive force in the period 1865–80. And by now, this tool has become improved to the degree that it has three or four speeds in each direction, low-pressure hydraulic steering, and gasoline or diesel high-speed heavy-duty engines.

The hauling of earth was improved, too, in 1850, when a self-loading cart was invented. Almost 75 years later, the scraper became a self-propelled vehicle. And the improvement since has been truly phenomenal in the direction of making the device more and more flexible, and in adapting the improvements in motive power.

Power graders and blade graders, too, were invented and perfected to solve a real need as the standards of construction rose and adequate road maintenance was needed for the growing highway network. The earliest bulldozers were animal powered, while the current diesel-driven "dozers" are possibly the most flexible and useful devices in the entire industry. The motive power unit, the self-laying-track type tractor, was a development of the early part of this century. In the twenties the use of horses and mules for power was replaced by the gasoline engine.

In the early thirties construction costs were further reduced by substituting diesel power for gasoline. In the late thirties costs were lowered still more by the use of rubber tires, the development of rigs of greater speed, the improvement in ease and safety of operation, and the production of units of greater capacity.

Early in the twenties, the US Bureau of Public Roads, together with a number of the state highway departments, began a study, as an aid in budgeting procedures, of the costs of various road-building operations. One of the processes receiving attention was that of excavation, and as a record-keeping device, a cost index was developed. Of this index, the Bureau has said:

"Since the index was started we have made a continuous study of the contractors' costs as determined by wage rates and the price of equipment and materials plus other factors. Over the years there has been a continued rise in labor rates, in the price of equipment and materials, and in the contractors' overhead. If these increases had not been offset by the development and skillful use of modern construction equipment, road excavation costs today would be about three times as great as they actually are."

This is borne out by the price trend for common excavation. The Bureau of Public Roads index started in 1922 is based on the average of all federal-aid projects awarded by all the state highway departments. The base period for the BPR index is the five years 1925 through 1929.

The Bureau's index shows that for the last 25 years common excavation costs were reduced continuously, as shown by the graph on Plate 10. In the early 1940s construction prices rose as a result of the impact of World War II with its greatly increased wage rates, higher prices for materials, shortage of equipment and decreased efficiency of labor.

In contrast to the reduction of the cost of common excavation, wage rates on road work climbed continuously during the same years. Plate 10 also gives the average hourly wage rates for unskilled labor on all federal-aid projects. The national average, which was 38 cents for 1926, in 1951 had skyrocketed to \$1.27, an increase of 243%. As a matter of interest, the average price for roadway excavation on contract work in California during the spring of 1953 was \$1.22 per cubic yard. Moreover, today's skilled labor is used on many operations on which unskilled labor was employed in the past. The variation in the highway excavation index as compared with average unskilled wage rates is shown in the graph at the top of Plate 10, and this indicates the continuous downward trend (excluding the war years) of the real cost of excavation. The ratio represents the unit price of excavation, the index figure, as compared to the hourly wage rate for unskilled labor. The continued decrease in the cost of common excavation was obtained despite the continued increase of refinements in specifications and engineering designs.

This period of cost decrease, and therefore of a better use of man's energies, occurred during the period of greatest advancement in the adaptation of heavy mechanical equipment to the road-building industry—for this was when the bulldozer was developing, diesel power was replacing gasoline power, vehicles were being speeded up, and the units were increasing in capacity.

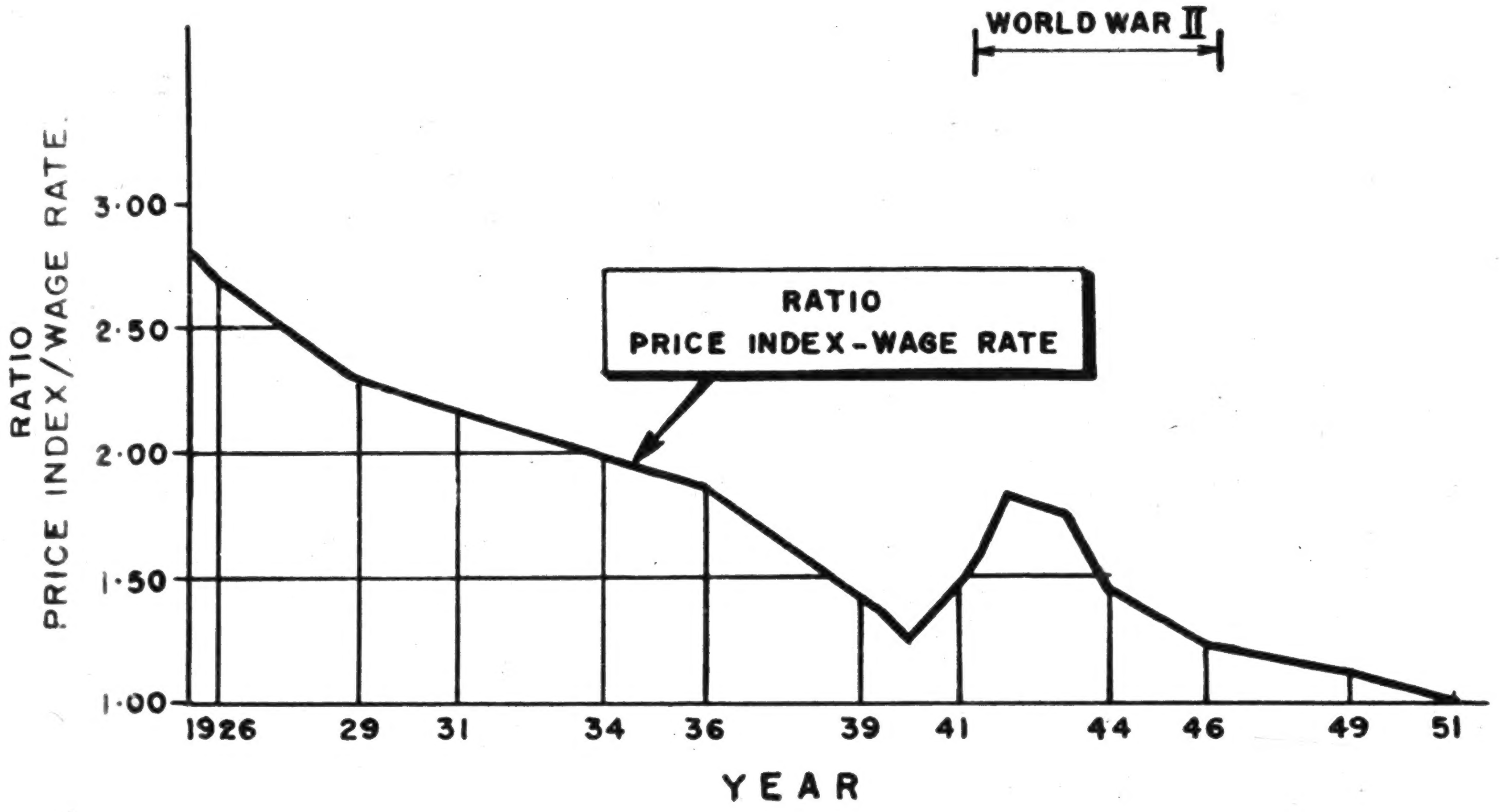
The progressive mechanization of the operations of road construction and maintenance has also brought about rapid advances in paving techniques. Probably the greatest development has been in compaction equipment, for better consolidation of materials has produced better subgrades, better foundation courses and improved methods of surfacing. The costly paving failures of the past, especially in non-rigid surfaces on secondary and county roads, have been largely eliminated or avoided. Also, by the use of the newer methods, it has been possible to gradually reconstruct the pavements already placed and in use, and thus to lengthen their lives also. Along with bettered compaction has come improvement in the grading of the mineral materials, in order to produce better structural characteristics of the pavement surface and subgrade, and in the application of the asphaltic materials to the surfaces. Rapid advances have been made in the technology of asphalts, especially in the cutbacks and in emulsified asphalts, to make them more suitable for highway surfacing and to permit their application during a greater portion of the year, and thus to gain a greater utilization of equipment.

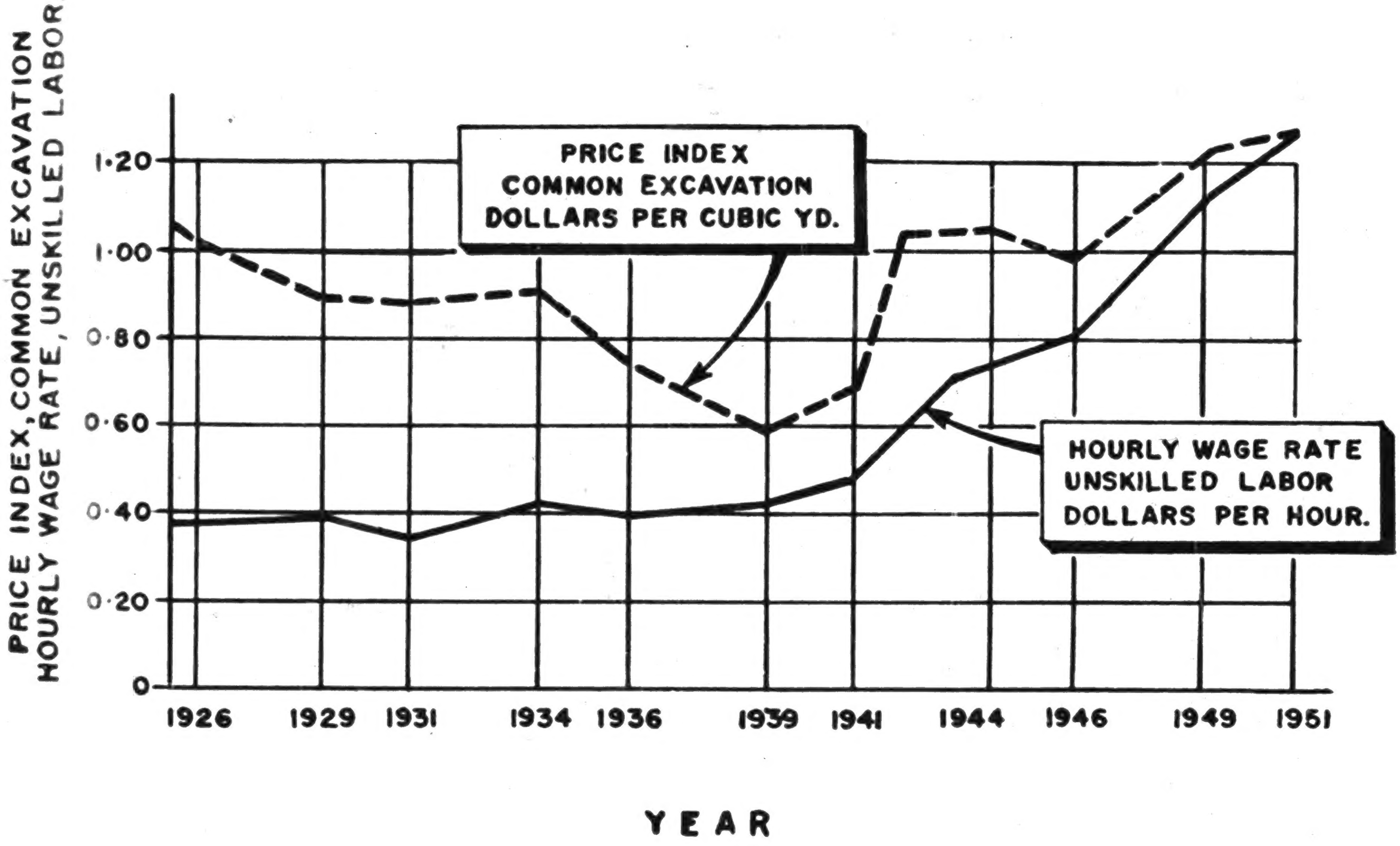
Because some of the techniques are new to engineers and highway administrators in Burma, and because the improvements in existing methods have been very rapid in the United States, especially in the last decade, it seems wise to review current American highway practice for the construction of several types of pavements, especially those with non-rigid asphaltic surfaces. Many of the newer techniques can be readily applied to the rehabilitation of the highway system of the Union if well carried out by careful operators and construction men, and properly guided by engineers with experience in the methods. Specific recommendations are made later in the report for the accomplishment of this program.

One development especially merits the serious study of the Department, and that is the method of road construction which has come to be known as "road-mix." Of the more recent advances that have come into being with the mechanization of the highway-construction industry, this process offers the greatest advantage in the reconstruction of some portions of the road network of the Union. The general features and requirements are therefore more fully described below, in order that its application and limitations may be understood. A typical specification for the construction of this type of surface is also included.

a. Sand-clay Roads

Production of a sand-clay road consists in the proper selection of materials and in their proportioning and proper combination under good moisture conditions. In areas where gravel or crushed stone is expensive, and especially where cheap labor is available, the modern sand-clay road is economical for traffic





MINISTRY OF NATIONAL PLANNING.

HIGHWAYS

EXCAVATION COST

U.S. HIGHWAYS.

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK. RANGOON.

DR. BY. E.J.P DATE PLATE
CK. BY. J.L JULY 53. NO. **10.**

densities of less than 500 vehicles per day. Later, as traffic develops, it can serve as a subbase for a pavement surface.

It has been found that the best results are obtained when the maximum clay content is approximately 25% of what is called the "topsoil mixture," although a proportion of 20% is preferable. The object of the whole construction operation is to secure the maximum density of material in the upper three or four inches of depth.

In compacting the road material, the use of three-wheel power rollers has not been found especially effective. Team and traffic action, however, has a very good effect. The rollers used for compaction should be of the sheep's-foot type or the old-fashioned ring roller.

It has now become common practice to crown the road to a slope of $\frac{3}{8}$–$\frac{1}{2}$ inch per foot. Generally also, the surface width in the US has become established at approximately 20 ft. for two-lane traffic, and, with a 30-ft. road bed, 4-ft. shoulders are available. It is considered preferable that the shoulders be treated in the same manner, with a thin sand and clay mixture.

Perhaps the best indication of the general requirements for the construction of a sand-clay surface course or a subbase for a pavement surface will be given by a detailed specification for a particular case. This is given in the following exhibit in which specifications covering the materials, construction methods and basis of pavement are shown. The specification also indicates, as a side product, the current American practice in detail specifications, which is somewhat different from that in use in Burma. It is essentially a "performance" specification so framed that the engineer can compel the contractor to adhere to the various requirements.

SPECIFICATION FOR TOPSOIL OR SAND-CLAY SURFACE COURSE

(ALSO SUBBASE OR SUBGRADE)

Description

This item consists of a surface of topsoil, sand-clay, or artificially mixed sand and clay constructed on the prepared subgrade under these specifications and as shown on the plans.

Materials

General. The surfacing material shall consist of topsoil or natural sand-clay of quality equal to that obtainable from locations designated by the engineer or of an artificial mixture of sand and clay, each of quality equal to that obtainable in pits designated by the engineer. All material shall be subject to prior tests and free from foreign matter and pebbles on a 1-inch round screen.

Tests. Surfacing material shall meet the following requirements:

(*a*) *Clay.* Material separated by subsidence eight minutes through water and possessing plastic adhesive properties.

(*b*) *Silt.* Fine material other than clay which passes a 200-mesh sieve.

(*c*) *Sand.* Hard material, usually siliceous, which passes a 10-mesh sieve and is retained on a 200-mesh sieve. From 40 to 60% of sand shall be retained on a 60-mesh sieve.

(*d*) *Coarse Material.* Hard material of gritty nature retained on a 10-mesh sieve and passing a 1-inch round opening. Sand and coarse material shall be free from feldspar, mica, schist, hardpan, or other soft or friable material in excess of 5%.

(*e*) *Material Passing* 10-*Mesh Sieve* when subject to mechanical analysis shall meet with the following requirements: clay, 9 to 25%; silt, 5 to 20%; and sand, 60 to 80%.

Construction Methods

Placing, Mixing and Shaping Topsoil and Sand-clay Surfacing. Placing sand, clay, natural sand-clay and topsoil shall start at a point farthest from the source of supply and progress toward the source. Hauling will not be allowed over the material placed until mixed and shaped as hereinafter specified.

The material deposited each day shall be twice plowed and harrowed, except when judged by the engineer to be too dry or too wet. Plowing shall begin on the outer edge and the material turned away from the center, then thoroughly harrowed with a cut-away disk harrow until pulverized; it shall then be plowed again beginning at the center and turning the material toward the center, then again harrowed with a cut-away disk harrow until the surfacing material is thoroughly mixed and pulverized; after which it shall be shaped by a standard road machine weighing not less than 2,500 pounds, to the cross-section and grades shown on the plans, and so maintained until accepted. During the process of plowing, harrowing and shaping, the contractor shall, at his own expense, rake or throw out any roots, sod, weeds and stones. Unless the materials contain sufficient moisture to insure proper combination and bond, they shall be sprinkled as directed by the engineer.

When the road under construction is being used by the public, the contractor, at his own expense, shall keep the subgrade and surfacing in such condition that the traveling public may use the road with comfort and safety.

Where the surfacing material consists of either approved *topsoil* or *natural sand-clay* without any admixture, it shall be evenly spread on the subgrade to such depth that when completed the surface will have the thickness shown on the plans. Compacting usually is one third of depth of loose material. The material shall be dumped on the subgrade in longitudinal rows containing not more than one third of a cubic yard to ten linear feet, and the number of rows shall be such that when the material is spread, the desired cross-section and thickness of surface will be obtained. After sufficient material has been dumped for one hundred to two hundred linear feet of surface, and before any part of the rows have commenced to pack, the material shall be spread approximately to the required cross-section and harrowed to secure uniformity.

When the surfacing material is to consist of an *artificial mixture of sand and clay made by mixing the material of the roadbed with sand or clay from some other source*, the construction shall proceed thus:

(*a*) The surface of the roadbed shall be thoroughly loosened and pulverized to a depth of from four (4) to eight (8) inches, according to the nature of the two materials to be mixed, first by plowing, then by harrowing with a cut-away disk harrow.

(*b*) The material to be added shall be dumped and spread in the manner described above to form a loose layer of from three (3) to eight (8) inches as directed by the engineer.

(*c*) The added material shall then be thoroughly mixed and incorporated with the pulverized material of the roadbed. This mixing shall be done by means of plowing and harrowing as above specified and shall continue until the two materials are thoroughly mixed in proper proportion.

(*d*) If after the two materials have been mixed as above described, any deficiency of the added material is apparent at any point, such deficiency shall be immediately corrected by spreading more of the required added material at that point and continuing the mixing as above described.

(*e*) After the mixing is complete, as above specified, the road shall be shaped and maintained as provided above, except that wherever later a poor mixture is observed, it shall be corrected by additional mixing or by adding necessary material and mixing.

When the surfacing is to be a *mixture of sand and clay, both of which materials are obtained from outside sources*, a layer of clay from three to six inches in depth shall be evenly spread and thereon a layer of sand of four to eight inches, and the two layers thoroughly mixed and shaped as above specified.

The order of spreading the clay and the sand may be reversed if required by the engineer.

Remixing and reshaping. If at any time before acceptance of the job, the surfacing materials appear to have been improperly mixed or exhibit a deficiency of either sand or clay, the contractor shall remix and reshape the surfacing or shall add material shown deficient as directed by the engineer and then remix and reshape the surfacing which appears unsatisfactory and again reshape the surface. After each rain prior to the acceptance of the job, the contractor shall repeat the process of remixing and reshaping.

Basis of Payment

This item of sand-clay surfacing will be paid for at the contract prices per cubic yard of sand-clay or topsoil surfacing in place, which prices shall include all clearing, grubbing, loosening, loading, spreading, plowing, harrowing, incidental work and hauling of surfacing material, and all labor, tools, and supplies necessary therefor. It shall also include all mixing, shaping, and maintaining true to section prior to acceptance.

As with almost all low and intermediate types of pavement, the sand-clay road needs constant and careful maintenance. The main portion of the operation is the dragging or blading to keep the road shaped and to eliminate any depressions that appear. Blading done after the material has been slightly softened by rain is preferable and light equipment can be used. The use of patrol graders has been found to be the best form of maintenance for this type of road. The cost of ordinary patrol maintenance, if the traffic does not exceed 600 vehicles per day, will average \$220–\$275 per mile per year. With a density of 400–600 vehicles the total annual cost of services appears to be moving in the direction of about \$1.25 per vehicle per day.

It has been observed that with this type of mixture of basic materials the fundamental composition of the mixture is retained, with proper maintenance, for approximately five years, and the average life of the road has been found to be about nine years. Previous to 1930, and based on many projects with this type of construction, the original cost was found to be approximately \$1,850 per mile, and the present cost approximately \$2,650 per mile. The present total cost of maintenance per mile averages \$565, broken down as follows:

Annual depreciation, based on nine-year life	\$261
Interest at 5%	74
Annual maintenance	230
	\$565

b. Crusher-run Base (Slurry Base)

The use of macadam paving in the United States has undergone several stages. In recent times it became less used because of the cost of placing the material. In about 1936, however, the State of California developed a modern macadam pavement which was called by them "Slurry Base." The use of this method of base construction became quite widespread and the process is now generally known as "Crusher-run Base."

Essentially, the mineral material is clean quarry waste, broken stone, crushed gravel, or a combination of these, all material being able to pass a 2½-inch sieve. Further, 30–50% must pass a ⅛-inch sieve and 7–14% must pass a 200-mesh screen. In California the practice is generally to use the material in a thickness of five inches. The 1937 unit cost was \$1.50 per ton or \$2.25 per cubic yard in place. The corresponding current prices are \$2.10 and \$3.15 respectively.

This material, as a base course, is used under bituminous surfaces, and a tack coat is spread first on the slurry base.

c. Gravel Roads

The use of gravel roads is gradually decreasing in the United States although many tertiary local roads are still of this material. As shown on Plate 5, more than one half of the total urban road mileage is now surfaced.

Generally, eight inches of loose material is placed on the surface and then compacted to approximately six inches in thickness. The cost of such gravel in place is currently about $1.60–$1.75 per cubic yard. On this basis a five-inch by 28-ft. base course would include 3,057 cubic yards of material per mile at a cost of $5,100. Also the three-inch compacted 22-ft. top will total $2,400 per mile and the total cost per mile is thus $7,500.

In the construction of gravel roads, the major items of cost are the stripping of the deposits at the pit, the loading to the crusher, the crushing process itself, the haul to the site, the separating of the gravel material and the blading and shaping of the surface.

d. Crushed Rock or Gravel

The untreated crushed rock or gravel road has been developed as an economical secondary and tertiary highway facility where the total daily traffic does not exceed 450 vehicles. It has been found that these materials can be crushed to a size of approximately one inch very cheaply, and bond well. In Oregon, as early as 1924, on a 20-mile road project, with a haul of 5·2 miles, the construction cost was $2.75 per cubic yard. On this project the base course was 1½ inches in maximum size and the surface course ¾ inch.

It has been found necessary to keep the size of the particles in the top course to at least no larger than those in the bottom course. If this is not done, any oil treatment of the surface will tend to bring the larger pieces to the top.

A traffic density of about 450 vehicles per day is the dividing point between a dry stone or gravel surface and an oil-treated surface. One factor in the choice is the dust which accompanies heavy traffic and the other is that with this vehicle density there is a tendency for corrugations to develop transversely with the surface.

The maintenance of a crushed rock or gravel road is a combination of motor blade patrol work with supplementary gangs using motorized equipment. These gangs supply extra gravel and do extra blade grading and scarifying. It is essential that the maintenance be very carefully done in the early spring, following the winter frost, and the late fall. In the latter case it is quite essential to see that the drainage system is working well.

The maintenance of the secondary state and county roads is a difficult problem since the operations are quite varied and also scattered in area. This results in a high overhead cost. While it is important to keep account of the cost per vehicle-mile of traffic, the knowledge of the total cost per mile is very important for budgetary reasons. In establishing the total cost, it is necessary to adhere to a very strict system of rental charges against equipment. If this is not painstakingly done the total cost of operations may be completely false and incomplete. When the traffic on a crushed-stone road is at or near its maximum operating capacity the loss of gravel, which must be constantly replaced during the maintenance operation, will total $400–$425 per mile per year on a 22-ft. roadway.

For this type of construction prompt and watchful maintenance is also necessary. The sections for the use of motor patrol maintenance should be 20–25 miles in length. The crew consists of two men with a truck having a drag planer or a scraping grader and numerous small tools. The surface is kept smooth by planing or dragging and this can best be done with two 3-ton trucks having demountable blades, for these can be removed and the trucks used in hauling materials as well. For light blading, such as is commonly used, the blade should operate at a speed of 8–10 miles an hour. Bladers propelled by a caterpillar tractor are also now in widespread use, the blades being 8 ft. to 12 ft. in length.

This is a hard use to subject a metal blade to, since its original depth of ten inches may be reduced to as little as three inches in from two to three weeks if the vehicle travels 25 miles a day.

The costs of the maintenance operations are estimated to be as follows:

	Per mile per year
1. Prior to surface treatment	$42
2. Cost of patrol	$20
450 vehicles—total cost will be	$62

or approximately $1.40 per mile per vehicle per day.

e. Road Mix

Since about 1926 there has been developed a new type of asphalt-mineral road in the United States in which liquid asphalt is incorporated to a compacted depth of about 2½ inches in the top of old and new gravel and crushed rock roads. The process is commonly called "road mix" and is also known as "oil mix" or "mixed in place." The mixture of oil with the mineral materials is made in place on the road, by wholly mechanical equipment. It is necessary to use scarifiers and tooth harrows to break up the surface lumps, after which the material is bladed to secure a uniform distribution. Hot oil, at a temperature of 100° F. or more, is then applied with a pressure distributor in increments with mixing between passes, the latter being effected with spring tooth or disk harrows. Following this step the entire mixture is bladed across the road surface and finally into a central windrow. When the material is fully mixed the windrow is taken down by blading to an accurate cross-section, and the road is then opened to traffic. It is sometimes rolled first, and possibly a seal coat of light asphalt is applied later.

The road mix must be placed on a solid base and dry, stable subgrade. It has been found that a four-inch consolidated base course is the minimum that should be used. It is common to lay the base course a season in advance, followed by a prime coat. Slow-curing asphalts are used if the materials are densely graded and rapid-curing types are used with material having a very open grading.

It is essential to use graders having blades of sufficient length, preferable 12 feet or more, and with ample motive power. Two-, three- or four-blade graders are often used in tandem. The blades should be set at an angle approximately 45° to the roadway and the vehicle should be operated at a speed of 4–5 miles per hour so that the material will roll and not slide as it leaves the blades. The full process takes 30–40 bladings, including the windrow. It is essential to have good equipment, amply powered, and very careful operators are needed in order that the process be carried out uniformly. The common optimum is to use 4% of oil by weight. Material can be taken from roadside pits, although crushed aggregate is preferable, the limiting size being one inch. There is included, below, a current specification from one of the state highway departments to indicate in detail the current requirements and practices in construction of a road-mix base course and surface.

ROAD-MIX BITUMINOUS SURFACE COURSE (CLASS C)

D701. *Description*

This item consists of an intimate mixture of aggregate and bituminous material, mixed on the road, compacted by rolling and finished with a seal coat, the whole constructed on a prepared base in compliance with these specifications and conforming in all respects with the lines, grades, thickness and typical cross-section shown on the plans, or as otherwise specified.

D702. *Materials*

The materials used shall be those prescribed for the several items which constitute the finished work and shall comply with all the requirements for such materials as set out in this specification and in Division III, "Material Details." Specific references to Division III are as follows:

Materials	*Reference*
Coarse Aggregate,	
Class A or B, Size No. 7, 8, 9, 63*, Crushed Stone, Crushed Gravel, Slag	K1, K2, K3.
Covering Aggregate,	
Class A, Size No. 12, Crushed Stone, Gravel, Slag	K1, K3.
Bituminous Material for Mixture,	
Liquid Asphalt RC-2, RC-3, RC-4	M2.
Emulsified Asphalt AE-150, AE-200†, AE-M	M5.
Tar RT-6, RT-7	M6.
Bituminous Material for Seal,	
Asphalt Cement AP-3, AP-2, AP-1, AP-0	M1.
Liquid Asphalt RC-2, RC-3, RC-4	M2.
Liquid Asphalt MC-2, MC-3, MC-4	M3.
Emulsified Asphalt RS-2	M5.
Tar RT-9, RT-10, RT-11, RT-12	M6.
Blended Trinidad Asphalt LC, LD	M7.

Aggregate Sizes: No. 7 and No. 8 (¾ in. max.), No. 9 (½ in. max.)

* If size No. 63 aggregate is used, the gradation requirements shall be as set out in Section K3 except, the amount retained on the No. 100 sieve shall be 95–100%.

† To be used only when Size No. 63 aggregate is used.

D703. *Construction Methods*

D703.1. *Shoulders*

Except as otherwise herein specified, shoulders shall be constructed as set out in Article D503.2.

When the rolling of the final surface is started, the outside rear wheel of the roller shall cover equal parts of the shoulder and adjacent aggregate.

D703.2. *Preparation of Base*

If the proposal provides for base preparation, the kind of new base constructed or the reconstruction of an existing base, as the case may be, shall be done under application provisions of these specifications prior to spreading the material for road-mix surface.

D703.3. *Spreading Coarse Aggregate*

The coarse aggregate shall be spread upon the prepared base to such loose depth that will produce the compacted thickness of the lift for which it is intended. In general, the compacted depth of any lift shall not exceed two times the dimensions of the top size of the aggregate being used. If the required compacted thickness of any course exceeds two times the top size of the aggregate being used, the course shall be constructed in two or more lifts, as directed.

The aggregate shall be spread without segregation by the use of spreader boxes or other approved spreading devices. No material shall be dumped in piles and spread therefrom.

After the aggregate has been spread, it shall be shaped to required cross-section and be free from irregularities.

D703.4 *Applying Bituminous Material*

The distributor used shall be as described in Article C503.1. Spray bars spanning the entire width of the surface are preferred.

To the aggregate, spread as above described, the bituminous material shall be uniformly applied in one or more applications as directed, in a total amount of from 0·5 to 0·7 gallons per square yard per inch of compacted depth, the grade and exact amount to be as directed. The aggregate shall be substantially surface-dry when the bituminous material is applied.

If a machine method of mixing is used, the engineer may direct that a heavier grade of bituminous material be used than would be used for road-mixing.

If liquid asphalt or tar is used, the application temperatures shall be as directed but shall not exceed those set out for the respective materials in Part M.

D703.5. *Mixing*

D703.5(*a*). *Road-mixing*. Immediately after any application of bituminous material, the aggregate and bituminous material shall, unless machine-mixing is used, be thoroughly road-mixed for its entire depth. Mixing shall be done with blade graders and multiple-blade maintainers, or other mixing devices if approved by the engineer. Mixing shall be such that all particles are thoroughly and uniformly coated and segregation avoided. After mixing, the mixture shall be evenly spread over the surface, true to grade and crown.

If the initial application of bituminous material does not sufficiently coat the aggregate, it shall receive an additional application sufficient to satisfactorily coat the aggregate and then be mixed and spread as before. If the edges appear to be too dry, an additional light application shall be made where needed. If directed, the mixture shall then be maintained in place by dragging with a drag or planer, the base of which is not less than 18 feet, until a uniform surface results, and until the bituminous material has hardened sufficiently to permit rolling.

D703.5(*b*). *Machine-mixing*. In lieu of road-mixing as above described, any machine method of mixing or mixing and spreading may be used if approved in writing before the work is started. Original approval shall not necessarily constitute continued approval if either of these methods as used does not give satisfactory results, in which case the contractor shall use the method described in D703.5(*a*).

If a machine-mixing, or a machine-mixing and spreading device is used, the device shall be designed as a unit and be capable of producing a uniform and well-coated mixture.

D703.6. *Rolling*

As soon as the properly mixed and shaped mixture has cured so it will compact without undue distortion, it shall be thoroughly rolled. Rolling shall be as specified in Articles D404.7 or C704.4, depending on the type of surface being constructed.

D703.7. *Checking and Correcting Surface*

Just before the rolling is complete, the surface shall be checked transversely with a template cut to the required cross-section and longitudinally with a 20-foot straightedge. Any variation exceeding ¼ inch will be plainly marked on the surface and shall be corrected by patching with a mixture of No. 63 or No. 11 aggregate as directed, and the same kind and proportions of bituminous material as used in the surface course. This patching mixture may be mixed under the mixing methods set out in Article F2402.1. If directed, the surface under the patches shall be primed with from 0·05 to 0·10 gallons per square yard of the same kind and grade of bituminous material used in the road mixture. The mixture shall be spread carefully over the area to be patched, using hand-raking if necessary. After spreading, patches shall be rolled and made to conform with the surrounding surface.

Any areas which develop an excess of bitumen shall be removed and replaced with proper materials.

D703.8. *Curing and Maintenance*

After the surface has been checked and corrected it shall be allowed to cure for ten days, during which time the contractor shall repair any areas which may have become damaged by traffic or other causes.

D703.9. *Sealing*

At the expiration of the curing period the surface shall be sealed as provided in Article D404.10.

D703.10. *Protection of Surface*

Any foreign material which may have accumulated on the surface shall be removed before the distributor, roller or any other traffic passes over it.

D703.11. *Seasonal and Temperature Limitations*

No surface shall be constructed between September 15 and May 15 without written permission of the engineer.

No bituminous material shall be applied when the air temperature is below 50° F., nor when the air temperature within the preceding ten hours has been below 35° F.

D704. *Measurement and Payment*

The quantities, complete in place and accepted, will be paid for at the contract unit price per ton for "Coarse Aggregate" including that used in patching, per ton for "Covering Aggregate," and per gallon for bituminous material applied including that used in patching and priming under patches, which payment shall be full compensation for furnishing, hauling and placing all materials, constructing shoulders and preparing base except as may be otherwise provided, checking and correcting surface, curing, maintenance, disposal of surplus material, and for all labor, equipment, tools and incidentals necessary to complete the work specified.

The specifications for the road-mix base course are similar, and incorporate the following requirements as well:

C802. Materials, admits medium curing asphalts MC-2, MC-3, and MC-4 for the base course only; the primer on the base course is restricted to RC and MC liquid asphalts, emulsified asphalt and RT tars; and the base course is to be laid on a hot asphaltic concrete subbase.

D703.7 is omitted, and the following three articles are added:

C803.3. *Checking and Correcting Surface*

After the final rolling is complete, the surface shall be checked transversely with a template cut to the required cross-section and longitudinally with a 10-foot straightedge parallel to the centerline. Any indicated variations exceeding ¼ inch shall be corrected with coated aggregate of the directed size. Coating shall be with one of the materials listed in C802 for patching mixture and the percentage of bitumen to be as shown in Article D404.1, if patching is with open-graded aggregate. If No. 63 aggregate is used, the amount of bitumen shall be from 2½ to 4½% exclusive of water or solvent. This patching mixture may be made under the provisions of Section D4, or it may be mixed by the mixing method described in Article F2402.1, as the contractor elects.

The patching mixture shall be placed and carefully leveled over the area to be patched, using hand-raking methods if necessary. After spreading, the patches shall be thoroughly compacted with a roller and made to conform with the required grade and cross-section. Unless otherwise directed, the surface under these patches shall be primed with approximately 0·10 gallons per square yard of any one of the materials listed in C802 for prime on base.

C803.4. *Prime Coat*

The need for and the application of a prime coat on the otherwise finished base shall be as specified in Article D404.8 for prime on binder, except the bituminous material shall be one of those listed in C802 for prime on base.

C804. *Measurement and Payment*

The quantities used in constructing the base, complete in place and accepted, will be paid for at the contract unit price per ton for "Aggregate" including that used in patching, per gallon for bituminous material applied including that used in patching mixtures and for priming, which payment shall be full compensation for furnishing, hauling and placing all materials, preparation of subgrade and construction of shoulders except as may be otherwise provided, mixing, patching, checking and correcting surface, disposal of surplus materials, and for all labor, equipment, tools and incidentals necessary to complete the work specified.

f. Plant Mix

"Plant Mix" is an outgrowth of the process of road mixing, with a closely controlled composition of ingredients. It was found that more viscous grades of oil, requiring heating, could be used. Originally the hot mixture was delivered in trucks to the road site, dumped into spreader boxes on trucks, and then spread. Later mechanical spreaders and finishers, such as the Adnun and Jaeger, were developed. These machines, in operation, are fed from the back of the moving truck.

With the use of heavier cutback asphalts it is necessary to postpone the rolling of the surface in order that evaporation may reduce the solvent content of the asphalt, and traffic should be detoured at this time, as well. With mechanical finishing it is not necessary to do further blading since the economy and uniformity of the machine output would be destroyed.

It is preferable to use the plant mix technique on roads of moderate and high density, as there is no windrow and the traffic can more closely follow the operation. There is also an advantage in using heated material since the working season can extend farther into the fall. The cost of plant mix surfaces is only slightly higher than the road mixes. The plant mixture is generally laid two to four inches in thickness loose measure, and under rolling and traffic the compaction is as much as 25%.

As the production rates for road mix operations under good management, 1,500–2,500 feet of finished 22-ft. pavement can be laid in one day with one setup. The necessary basic equipment for such a setup would be:

(1) A first-class 1,500-gallon tank distributor mounted on a ten-ton truck, and costing in the neighborhood of $10–13,000.

(2) Three or four self-powered pusher graders with a 12-feet by 20-inch blade.

(3) Disk and spring-tooth harrows having a width of half the roadway.

(4) A service truck and small tools.

This equipment is for the road operation only. The supply and distribution of material to the work site requires a plant, or rail delivery, an adequate truck fleet, and one or two spreader boxes. It is very easy, with good management, to achieve production and delivery of 1,200 tons of material in an eight-hour day.

As on all continuous mechanical operations, every effort should be made to avoid interruptions. Even minor interruptions are costly because the hourly operating costs continue through the period of no production. It is necessary to have a continuous flow of bituminous material to the work, and the dry ingredients must be on hand and spread in advance of the arrival of the bituminous material. The supply operation must be well organized, there must be well maintained service roads, and the drivers must give good performance.

g. Cost

As a convenient method of cost comparison, road mix surfaces are often priced per inch of depth over an area of one square yard. In 1936 the average price of this material for 120 projects in eight states was 13·4 cents. At this level, a 2½-inch surface costs 34 cents per square yard or $4,400 per mile. Currently the price is approximately 18 cents and the per-mile cost $6,500.

With no new mineral material added, the cost of labor equipment and liquid bituminous material for the maintenance operation will total about $2,650 for a 20-ft. pavement of 2½-inch compacted depth. The costs are as follows:

Scarifying and pulverizing	$300
Three passes of oil	$240
18,000 gallons of oil	$1,260
Blading, and miscellaneous	$850
	$2,650

The plant is generally set up at the material supply source, either pit, quarry or rail siding. It consists of a ¾-yard crane, a pugmill mixer, and appropriate heaters for the asphalt and drying units for the aggregate. An experienced mechanic is necessary for plant service. Screening of aggregate has become a common practice to improve the quality of the mixture.

As indicated earlier, finishers have replaced the spreader boxes and with these the mixture is placed and screened at a rate of 150–180 tons per hour. The compaction is commonly accomplished by three-wheel ten-ton rollers and with some cutback asphalts it is necessary to defer their use to permit solvent evaporation. The plant mix operation is best when carried out in clear, hot weather.

h. Maintenance

The best maintenance for surface of bituminous material is immediately to take care of small patching as the depressions appear, and the renewal of the surface with a thin application of bituminous material. Screenings are sometimes used. If there is raveling, oil and reprocessed surface material should be added. If the material has a tendency to shove along or to form ridges it is necessary to add more mineral constituents and to reprocess and reshape the surface. Patching can be done from stockpiles of mixed material along the route of the roadway. Portable heating plants are very effective and it has been found that the best technique is to build up the patches in thin layers. Asphalt emulsions are valuable in patching operations since they can be used in moderately cold and damp weather.

Also, good maintenance includes raising shoulders, ditching right-of-way, and work on small structures as on any road. The surface of road and plant mix pavement has been found to be good for almost any amount of traffic but the subgrade and shoulders must be prevented from becoming saturated with moisture, or even too damp. Failure occurs because capillary moisture tends to separate the courses.

During the period 1935–37, detailed cost studies were made on maintenance operations on numerous highways having plant and road mix surfaces. The results per mile per year, were as follows:

	Maintenance for Road and Plant Mix Surfaces	*Maintenance Outside the Surface*
1935	$140	$194
1936	$132	$164
1937	$156	$230

For the average of three years the maintenance cost per vehicle-mile per year was 31 cents for this type of construction. Currently, the total maintenance cost has risen to approximately $475 per mile per year—almost 40 cents per vehicle-mile per year.

i. Penetration Macadam

With this type of construction, the base course of mineral aggregate is compacted and the asphaltic material or tar is poured into the material in place. The penetration course is two to three inches thick. If placed on a good subbase the surface may later serve as a foundation course of a high type pavement, as traffic increases on the highway. Currently it is common practice to completely compact the base course before applying any bituminous material. Mineral aggregate used is that which will pass a 1¼ to 1½-inch screen. Generally, when bladed and compacted, the material will be about two stones thick. The asphalt is applied with a distributor, and it is preferable to heat the material.

In placing the intermediate course the keystone, to lock the surfaces, is spread uniformly, occasionally by hand from stockpiles, on the shoulders of the road. The general range of size for the keystone is one inch down to ⅝ inch.

The subbase of the penetration macadam pavement will be 8 to 12 inches in thickness, the maximum being needed in a severe climate. The material consists of broken field stone or gravel and is laid in two courses. If properly laid it serves also to prevent heaving and "boiling," and also as a drainage in bog areas. The top six inches of the material will cost $1,000 per foot of pavement width. Thus a road of 20 ft. width, exclusive of the subbase, grading and drainage structures will cost $20,000 per mile. This represents a cost of $1.70 per square yard, a very high figure. Based on contract experience $1.40–$1.50 would be a more common contract price. Generally in the northwest portion of the United States, an 18-ft. pavement is considered to cost $27,000–$37,000 per mile including grading and structures. In California and Oregon, where asphalts are relatively cheap, $1.20–$1.30 will be a preferable unit price. Here the cost of a 20-ft. road would be about $16,700 per mile. In the State of Washington, recent contract work has indicated the following prices:

Two-inch penetration surface	61 cents
Eight-inch base	79 cents
	$1.40 per sq. yard

The western figures are influenced by an adequate supply of cheap crushed stone, from the talus slopes in the mountain areas, at a cost of 70 cents to $1.50 per ton, and an asphalt price of nine to ten cents per gallon.

The cost of maintaining two-lane bituminous macadam pavements has tended to become $175–$200 per mile. Maintenance includes the periodical renewal of the surface, asphaltic coating material, seal coat, the elimination of waves in the pavement by rolling, and the patching of depressions. The roughness of the bituminous macadam surface, a common fault in the pavement, has been found to be often caused by an excess of asphaltic material. If there are construction defects in placing of the materials raveling will be common. In this case the immediate area should be completely rebuilt and the drainage watched to be sure of its adequacy. Emulsified asphalts are of help in the maintenance program. The rig for maintenance of penetration macadam pavement consists of a small truck bringing sand, pea stone, and tools, and hauling a 50-gallon kettle or emulsion outfit. One man sweeps the places to be patched and the second applies bituminous material with a broom or pouring pot. The third workman applies pea stone or fines, and looks after the fire in the kettle if hot patches are being made.

In severe climatic conditions the use of the harder asphalts is to be avoided. Winter maintenance of the pavement will include heavy sanding, and this may have to be carried on well into the spring. If the asphalt macadam is well built, it will not be necessary to apply a seal coat for at least six years after its opening. In the construction, care should be taken to avoid excess rolling of the softer stone before curing the asphalt. The base courses should not be rolled on a wet subgrade. The quantity of both seal coat and the soft bituminous material should be held down to the minimum possible. It is especially necessary that the coarse aggregate be hard and durable. The advantage of this type of construction is that it requires the minimum of heavy equipment, the road roller being the only large piece necessary.

j. Sheet Asphalt

Sheet asphalt has been found to be superior material for highway surfaces, especially city streets. If properly constructed, the maintenance costs are quite low, and will even reach a figure of ½ cent per square yard per year, although a figure of 1 cent to 1·25 cents is more common.

The average 1935 construction prices for sheet asphalt pavement in the South Atlantic States were as follows:

	1 inch of depth (cents per square yard)
Sheet asphalt	50–52
Binder	32–34
Cement concrete base	26–30
Black base	30–32

On this basis a three-inch pavement on a five-inch 1:3:6 base totaled $2.56 per square yard or $30,000 per mile. The same year, Portland cement concrete pavement was 38 cents per inch or $2.47 for a 6½-inch pavement, a total of $29,000 per mile for a 20-ft. wide pavement. Currently, the total unit price is $3.20 per square yard, or $37,500 per mile.

k. Portland Cement Concrete

Because the construction of Portland cement concrete pavement, both plain and reinforced, has become an important part of the whole highway construction program in the United States, more study has gone into its methods, cost factors, and other factors, than for other types of surface. It is commonly used for heavy duty pavement and as bases for sheet asphalt or other high type pavement. Several years ago the Bureau of Public Roads made detailed cost studies on 35 projects for this type of construction with the manpower and cost results listed below. It was found that the fundamental processes were the transportation, mixing, placing, finishing and curing of the pavement. The basic equipment consists of trucks carrying one to five batches of material to the mixer, a 27E paving mixer, and finishing machines which operate on the side forms of the pavement slab. Studies of the labor gangs on these projects indicate the following approximate distribution of men to the corollary operations:

		Men
Fine grading crew, 2–20	say	13
Form setting		11
Handling materials, including water		14
Crew at mixer, including truck drivers handling the dry batches to the mixer	average	15
Mixer, foreman and paver operator		2
Finishing crew—puddlers, spaders, machine operators, strike board and hand finishing, 6–23	say	11
Reinforcing-steel placers		2
Curing, 1–15	say	8
		76
Watchman, water boy, mechanic		3
Superintendent and timekeeper		2
		81
Of which truck drivers are		13

The equipment costs for such a setup were:

1. Total daily equipment items except field repairs, fuel, grease, oil	$204
2. Field repairs, fuel, grease, oil	$53
	$257

The equipment costs were based on a 7% lost time factor and the operation represents 17 working days per month. The over-all equipment efficiency is 78%. On the basis of this, equipment will produce and place 300 cu. yds. in a nine-hour day.

The payroll costs for this operation total (on the basis of productive time)	$298
Prorated, non-productive to productive time	$36
	$334

Batching and hauling are not included in the items above, but this is the portion of the operation in which interruption can cause the greatest loss in efficiency and money. Everything depends on having a continuous flow of materials to the work.

For a current analysis of the construction of concrete pavement, with current cost factors, see Table XVI–18 (*see p. 423*).

There has been a marked increase in efficiency in the use of working time in the paving operations in recent years. Job records kept previous to 1929 indicate that the job efficiency averaged 55%. During the period 1929–34, these operations were carried on at an efficiency greater than 85% and six actually exceeded 90%. This remarkable advance parallels the development and increasing use of mechanical road-building equipment, through the same period.

Generally, concrete pavement is paid for per cubic yard and often the cement is paid for as a separate unit. In 1930 ten million square yards of plain Portland cement concrete pavement were laid at an average cost of $1.78 per square yard, and 5½ million square yards of reinforced-concrete pavement at an average price of $2.16. Prices were lower in 1931–33 but they increased gradually in the next five years, and more into the war years. Currently, the average price for cement concrete pavement is about $5.40 per square yard, and the detailed analysis, by operation, is as shown in Table XVI–18.

The repair of cement concrete pavement consists in the doing of small patch work. Tamping of the material to consolidate it in the patches is important. If there are many depressions in the pavement the whole area between adjacent joints should be removed and replaced. The main maintenance operation is simple—to repair the joints and to refill them with hot bituminous material. In recent years surface scaling has become more common than in earlier time. The use of chains in vehicles in winter weather and the very general use of chemicals to prevent the formation of ice on the pavement, and to facilitate its removal from the pavement surfaces is becoming common.

The cost of maintenance for concrete pavement has an average value of $1,400 per mile per year, for a two-lane pavement.

3. CONCLUSIONS

Road materials are so high in cost in Burma that their use has to be planned and executed to secure the greatest possible utilization of the several items. This is especially true for bitumen and the aggregates in bituminous pavements.

The cost of mineral aggregates is so high in all parts of the Union that its use must be drastically reduced, and an adequate local supply of well-graded materials must be developed in each of the districts and areas.

Modern processes of construction must be studied and adapted to use here, in order that the rehabilitation program, which will require a very large expenditure of both men and money, may be carried out at a reasonable cost.

Failure to take parallel steps of reduction of materials cost and introduction of machines may lead to the collapse of the rehabilitation program for highways.

H. CONSTRUCTION AND MATERIAL COSTS

1. GEOLOGY AND MINERAL DEPOSITS

While the costs of processed aggregates for concrete construction and the placing of road surfaces are very high, as will be seen from Table XVI–15, there is an abundant supply of quarryable material in almost all parts of the country. The materials are used locally for building purposes to a limited extent, but only a very few deposits appear to be furnishing aggregates for the maintenance of the highways. Very little heavy mechanical equipment is in use at such quarries as are in operation, almost the entire operation being done by hand. This is wasteful of human energy, and the substitution of machinery in all quarrying operations, as recommended later in this Report, is a vital necessity if the cost of road materials is to be reduced and the production increased as it must be before the road can be rehabilitated.

The principal deposits and quarries are these:

(a) The Department quarries at Mokpalin in the Thaton District were opened up in 1923. The material is granite, with some gneiss, and is brought by rail to the Rangoon area, where it is the principal road metal. Laterite, as a shoulder material, is also brought from the Mokpalin quarries and is largely used in the Pegu District.

(b) Another source of laterite, though it is not as hard as that from the Mokpalin deposits, is the long narrow ridge in the area between the railway to Prome and that to Pegu, the ridge being an extension of the Pegu Yoma range. The material exists as a laterite, or lateritic clay, and the best deposits are at Wanetchaung Station on the Prome line.

(c) There are sandstone outcroppings, indicating material of unlimited quantity, just south of Prome. They show to the east of Route II, and conveniently close to the highway. The quality can very easily be established with some further investigation, and if suitable for highway purposes in this respect, the deposit should furnish sufficient aggregate for the highway supply requirements over a considerable area. Sandstones from this area have been used in building construction with good results. At present, crushed stone in this area is being supplied at K220 per 100 cubic ft., an exorbitant price. With a good modern quarry established, and well faced, it should be possible to produce material at one tenth the current cost.

(d) On Route I, between Mandalay and Meiktila, there are numerous outcroppings of a good commercial grade of limestone. A small commercial quarry, on a contract basis, is now in operation about one half mile east of Mile 26 (from Mandalay). The deposits seem to lie from one half mile to eight or ten miles from the present route of the highway.

(e) Crushed limestone is also a common road material in the Shan States, the current price being K35 per 100 c.f. Deposits and outcroppings are noticeable along all parts of Route IV east from Meiktila toward Thazi, Kalaw and Taunggyi.

(f) On Route III between Mandalay and Maymyo, there are countless and occasionally nearly continuous outcrops of good limestone. They occur on both sides of the highway and close to it, and there is scarcely any overburden. The route between Miles 17 and 30 is especially favorable, and the material, if quarried, could be shipped by rail from the station near Mile 25 on the highway.

(g) There is also much limestone showing on Route III, between Maymyo and Lashio. In most cases it is close to the road, and with some short-haul trucking it would also be feasible to ship it out by rail, using any of the several stations along this portion of the line.

(h) On Route III between Lashio and Hsenwi, numerous deposits of limestone show, especially near Mile 10 (from Lashio).

(i) In the Shwebo district, and also in the Lower Chindwin area, basalts have been quarried. All of these materials are fine-grained and non-vesicular, make durable road surfaces, and in some instances are locally called "granite."

These were only a few observations of outcroppings encountered upon the field inspection trips. Many others exist along the secondary roads in all parts of the Union. Later in the Report, a specific recommendation is made that the Department establish other quarries, purchase and install the necessary equipment, and seriously produce the very large quantities of road materials that will be needed for the rehabilitation of the highways, thus reducing the very high unit prices which are now being paid for road materials throughout the Union.

2. CURRENT HIGHWAY COSTS, BURMA

a. Labor Costs

Based upon data in the annual Report of the Department for 1950–51, it appears that the total labor cost for postwar work is about four times what it was prewar. The daily wage comparisons for the two eras are about as follows:

	Daily Wage	
	Prewar	*Postwar*
Unskilled labor	K0.50	K2.25
Carpenters	K2.00	K8.00
Masons	K2.00	K8.00

Also, as has been found true in a number of other countries, labor is much less productive now than it was before the war. For example, the prewar production per man on excavation was about 100 c.f. per day. Currently, the figure is 75 c.f., a reduction in output of one fourth. The governing factors which prolong this condition of less efficient output are labor attitudes and the lack of skilled labor (and therefore of other labor) in all parts of Burma.

b. Material Costs

The cost of materials has also had a phenomenal rise in Burma, as in almost every other country, since the end of hostilities. As typical comparisons, consider the following prices, for comparable situations:

	Prewar	*Postwar*
Cement, per cwt.	K2.00	K8.00
Teak, per ton	K150.00	K800.00
River shingle, or hill gravel per cwt.	K35.00	K115.00

Thus it is seen that the cost index for materials has risen about four times, approximately the rise for labor, between prewar and, say, 1950–51.

The current prices of specific road materials in different areas of Burma are shown below in Table XVI–15 for Portland cement, aggregates and bituminous materials. These should be compared to the corresponding prices for materials in the United States, as listed in Table XVI–20 (*see p. 425*), representing average prices for twenty cities. It will be seen that the aggregate prices in the upper Shan States tend to approach those in the United States, that the aggregate prices in lower Burma are very high, and that the price of Portland cement, even in Rangoon, is almost twice the average figure in the United States.

TABLE XVI – 15

COSTS OF HIGHWAY MATERIALS, BURMA, 1953

	Price Kyats/L.Ton	*Price Dollars per Bbl. (376 lbs.)*
Portland Cement		
at Rangoon	168	5.95
at Thayetmyo	213	7.55
at Mandalay	240	8.45
at Taunggyi	260	9.20
at Kyaukpyu	372	13.15

	Price Kyats/100 c.f.	*Price Dollars per c.y.*
River Shingle, Prome	80	4.55
Crushed Stone, Prome	220	12.50
Crushed Stone, Mandalay	60	3.40
Crushed Stone, Lashio	25	1.42
Gravel or chips, Mandalay	80	4.55
Gravel, ½ in. and down, Lashio	12	0.68
Bitumen, delivered to storage		
at Mandalay	450/L.Ton	84.50/ton
at Lashio	520/L.Ton	98/ton

Source: Field trips to Districts, 1952–53.

c. Total costs

Plate 11, "Cost Trends in the United States," has had added to it the corresponding graph for "Total Cost, Burma," representing the labor, materials and equipment costs by years. It will be noted that the costs rose very rapidly, and the figure of four as a ratio between postwar and prewar construction costs, as mentioned above, is an average figure.

This rise in the cost of materials and labor has an immediate reflection in the costs per mile of construction of various types of road surfacing, as shown in Table XVI–16. The minimum and maximum prices, per mile, are shown for the several pavements now in general use in Burma.

The cost of highway maintenance has also skyrocketed, though the fact that the work has not been as completely done as before the war has made the proportionate rise in costs seem less. For the same general pavements, the departmental reports reveal the maintenance costs to be:

TABLE XVI – 16

COSTS PER MILE—HIGHWAY CONSTRUCTION IN BURMA

	Prewar		*Postwar*	
	Minimum (K)	*Maximum (K)*	*Minimum (K)*	*Maximum (K)*
1. Bituminous Surface	40,000	60,000	140,000	200,000
2. Metaled Surface	35,000	52,500	122,000	175,000
3. Surfaced	11,000	15,000	35,000	45,000
4. Earth	3,000	—	9,000	—
5. Mule Track	2,000	—	6,000	—

Note: The costs per mile include structures, drainage and bungalows.

TABLE XVI – 17

MAINTENANCE COSTS, BURMA

	Cost per Mile, in Kyats	
	Prewar Average	*1950–51*
1. Bituminous Surface	1,000	2,450
2. Metaled Surface	1,400	2,720
3. Surfaced	740	1,830
4. Earth	280	1,090
5. Mule Track	70	115

These figures should be compared to the maintenance costs for corresponding types of pavements on United States highways, as in the text of Section G, Construction Methods.

3. HIGHWAY UNIT COSTS, UNITED STATES

In comparing the current costs of highway construction in Burma with those in other countries, where the use of mechanized equipment and modern techniques is more advanced, the costs shown below from current and study projects are applicable. A wide variety of projects in all parts of the United States and including several types of pavements, is included.

In the previous subsection, the effect of mechanization of operations on the unit price of common excavation has been discussed. It will be noted, from Plate 10, that the excavation cost on highway work in the United States has continuously declined for the last 25 years. The 1951 ratio of unit price of excavation to hourly wage rate stands at 1.0, the price index and the hourly rate for labor each standing at 1.27.

There is given in Table XVI–18, a detailed cost analysis for the construction of reinforced cement concrete pavement in the United States, based on 1953 price levels. As a matter of interest, actual bid prices in April 1953 for cement concrete pavement at several locations are as follows:

	Price per c.y.
Ohio: 8-inch reinforced-concrete base	$5.00
Ohio: 10-inch reinforced-concrete pavement	$5.40
New York: 11-inch two-course pavement, including cement	$4.80
California: 7½-inch reinforced-concrete pavement	$5.40

Table XVI – 18

COST ANALYSIS—CONCRETE PAVEMENT, 1953

Item	*Cost* $		*Per cent of Total*	
Cement	1.08		20	
Transportation to batching plant	0.38		7	
Subtotal	—	1.46	—	27
Coarse aggregate	0.49		9	
Transportation to batching plant	0.49		9	
Subtotal	—	0.98	—	18
Fine aggregate	0.19		3·5	
Transportation to batching plant	0.24		4·5	
Subtotal	—	0.43	—	8
Cost of cement, aggregate, transportation		2.87		53
Reinforcing steel, joint material, etc.	0.32		6	
Depreciation of equipment	0.48		9	
Labor and supervision	0.59		11	
Batch delivery, labor and equipment	0.38		7	
Overhead, interest bond set up, etc.	0.22		4	
Return to contractor including salary	0.54		10	
Subtotal	—	2.53	—	47
Total, per cubic yard		5.40		100
Total, per linear mile, 20-ft. pavement, 8" thick	$14,080			

Table XVI – 19

ESTIMATED COSTS PER MILE—PLANT MIX SURFACE

(20 feet wide by 2½ inches deep)

Outlay	*Projects*			
	A ($)	*B* ($)	*C* ($)	*D* ($)
Plant Mixture				
(*a*) Crushing-plant installation	257	878	348	364
(*b*) Aggregate production	954	1,766	992	779
(*c*) Mixing-plant installation	128	439	174	182
(*d*) Mixing (including drying)	442	433	460	361
(*e*) Haul	707	1,040	1,526	332
(*f*) Spread, finish, compact	442	434	460	362
Subtotals	2,930	4,990	3,960	2,380
Bituminous Material	1,680	1,960	1,190	1,330
Total costs per mile*	4,610	6,950	5,150	3,710
Project Data				
Length of projects (miles)	16·308	4·675	12·500	9·366
Kind of aggregate	Cr. Gravd.	Cr. Rock.	Cr. Gravd.	Cr. Gravd.
Average haul (miles)	4·0	6·0	8·3	2·3
Type bituminous material	MC–5	MC–5	MC–5	SC–4
Apparent actual profit	10%	26%	—	—

* Excluding any costs for base preparation, prime or seal, and on an average of 1,600 tons of mixture per mile.

Average cost of surface per linear mile	$6,400
Base course 6-inch crush stone	$3,000
Prime and seal coats	$700
Total cost per linear mile	$10,100

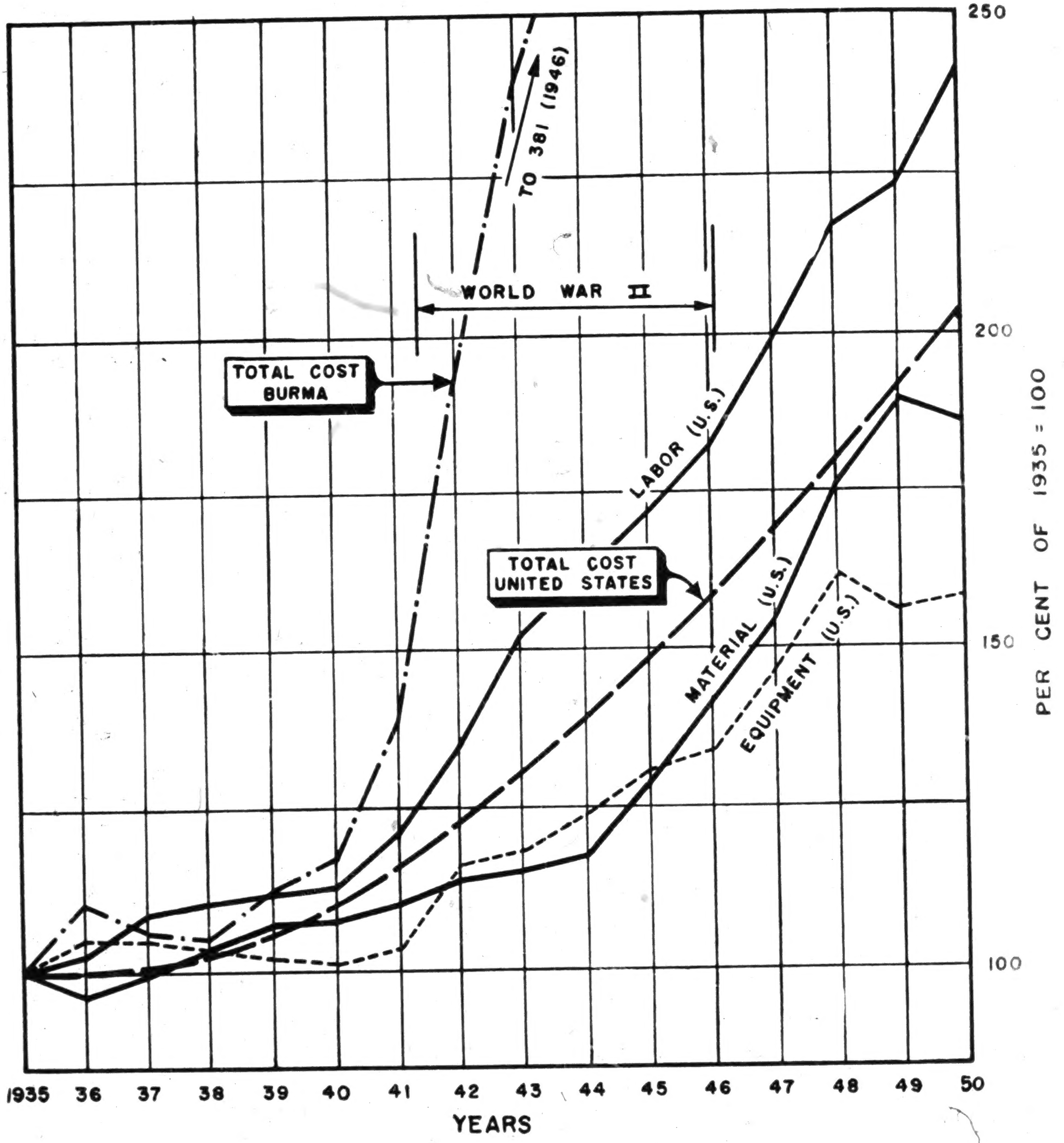
There is also given, in Table XVI–19, the estimated costs per mile of asphaltic concrete plant mix surface on four projects in the southwest United States, and which were constructed in 1936–37. The study was made on projects all of which had 20-ft. pavement surfaces, 2½ inches in depth. The four projects average to $5,100 per mile for this type of construction. The costs at present are higher, as are the wage rates paid workmen. Currently, in the same area, the total cost is approximately $6,400 per mile, one fourth higher than the 1936–37 figure.

In the subsection of the report devoted to modern methods of road construction, there are also to be found some general and average cost figures as to the current and recent price levels for the construction and maintenance of highway surfaces of various types.

The general picture as to price levels in the United States in the 15 years between 1935 and 1950 is contained on Plate 11. Based on the labor, material and equipment costs during 1935 as being equal to 100, the percentage change in each of these, and in their total, has been plotted year by year. It will be noted that the total cost in 1950 was 205% of that in 1935, and that labor cost had risen even more, to 240% of the earlier figure.

Partial data for these same years was available for Burma, and the graph of this information has therefore been superimposed on the United States figures, where comparable. It will be noted that the total cost in Burma had a tremendous rise during the war years. The peak was reached during 1946, when the total cost was 3·8 times the 1935 figure. At that time, the United States ratio was 1·6 times the earlier value.

For comparison with the prices of road materials in Burma previously listed, there is offered Table XVI–20 (*see p. 425*) in which the late 1952–53 prices for similar materials are shown. It will be noted that the average price of cement per barrel (376 lbs. = 1 barrel = 4 sacks) in the United States is only $3.15, while in Rangoon the cost is $5.95, almost twice as great. In other localities in Burma, the



TOTAL COST IN BURMA
PER CENT OF 1935=100

YEAR	%	YEAR	%
1935	100	1942	195
1936	110	1943	239
1937	105	1944	286
1938	104	1945	350
1939	112	1946	381
1940	118	1947	374
1941	163	1948	325

MINISTRY OF NATIONAL PLANNING

HIGHWAY
COST TRENDS
IN UNITED STATES

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON
DR. BY E. J. P. DATE PLATE
CK. BY K. B. W. MAY, 53 NO. 11

TABLE XVI – 20

ABSTRACT OF MATERIAL COSTS, 1952–53

(20 cities in United States)

Item	*Average* ($)	*High* ($)	*Low* ($)
Portland Cement, per bbl.	3.15	3.69	2.65
Portland Cement, at mill	2.70	—	—
Sand, per ton	2.08	2.50	1.35
Gravel, ¾-1½ inch	2.60	3.00	1.85
Crushed Stone, 1½ inch	2.55	3.77	1.40
" ¾ inch	2.60	3.71	1.40
Premixed Concrete, per cubic yard (1: 2: 4, 50 c.y. or more)	10.95	13.00	9.30
Pine Lumber, No. 2, per MBM	92.50	116.50	67.00

cement price is even higher, reaching the astronomic figure of $13.15 per barrel in Kyaukpyu.

Likewise the cost of crushed stone ranges both ways from that in the United States, the Prome price being $12.50 per cubic yard as compared to the $2.55 average figure in the US, and the Lashio price is $1.42 per cubic yard.

The processing and supplying of building and construction materials to jobs in the United States is a very competitive enterprise, and price levels at any given period are apt to exhibit only a very small range. Most of the differences in costs of materials arise from the transportation of the materials from mill, or mine, or quarry, to the job site.

With most materials being brought from sources as close as possible, the transport is largely by truck, except in the large metropolitan areas in which water transport by barge to some point close to the project site is feasible.

I. MAINTENANCE

1. PRESENT METHODS

The highway maintenance operations of the Departments of Buildings and Roads are carried on within the decentralized organization described in the preliminary report. The general policies to be followed, and the over-all programs are established in the office of the chief engineer. Funds are established by the general budgetary procedures of the department, are built into the annual budget for the Ministry, and are then appropriated by Parliament. The current maintenance costs for various types of pavement in Burma are tabulated in Table XVI–17, and comparisons with similar costs for modern crushed stone, road mix, plant mix and other types of pavement surfaces in the United States may be drawn. Hand maintenance is almost universal in Burma. Probably the only piece of road machinery that is in general use is the road roller. Tar for road use is heated in boilers, but the road gangs then complete the operation with pouring cans, brushes and brooms. Asphalt distributors have been used experimentally, but the results were unsatisfactory. As such equipment is in very common and successful use elsewhere, its lack of success in Burma indicates technical or supporting deficiencies. The maintenance tools in use are the mamvatie, the pick and the cane head-basket.

The prewar program comprised regular patching operations followed by general bituminous surface reconditioning each third or fourth year, depending on the budget limitations. Because of the need for widespread major maintenance and reconstruction to repair the destructive ravages of war and insurgency, the Department has not been able to furnish the degree of highway maintenance needed in any modern well-kept system. Good maintenance is vital for (*a*) the safety and comfort of the traveling public, and (*b*) the preservation of the capital investment.

Maintenance before the war, described as "needing one coolie per mile," can hardly have been adequate. Postwar repairs leave much to be desired. The occasional motorist is annoyed by having to travel at a low speed, to steer over raveled edges and around large chuck holes, but to the truck operator and even more to the bus operator, who is charged with the safety of his passengers, these shortcomings and inadequacies are both dangerous and costly.

2. MODERN METHODS

There are described, in Section G, the current American construction and maintenance techniques and the principal types of mechanical highway equipment. Many, if not all of these procedures and equipment could be adapted to use in Burma. If this were done, better and more systematic maintenance would result, the cost of maintenance would be drastically reduced, and the traveling public would benefit. The commerce, trade and developing industrial life of Burma would be advanced by having an adequate, well maintained highway network over which vehicles could travel safely at reasonable rates of speed.

3. LABOR REQUIREMENTS

The argument has been advanced that to mechanize the construction and maintenance of highways in Burma would result in unemployment. This need not be the case for the following reasons:

(*a*) Road gangs will not be eliminated but merely transferred to any of the numerous but now neglected supporting maintenance activities. Most important of these is the work required on drainage structures and ditches. If the drainage is not taken care of, the foundation of the highway will fail, and the whole system will again fall into disrepair.

(*b*) Many of the workers from the road gangs can also be retrained in the use of the new equipment. Others will be needed to staff the repair shops required for the new equipment.

In the United States and elsewhere, the mechanization of the highway operations has resulted in: (1) a greatly extended program and more adequate results, (2) less outlay for construction and maintenance and (3) increased employment. In this connection, and to illustrate the total manpower requirements of highway construction and maintenance, there is introduced Table XVI–21 in which the total number of employees for several categories has been shown for each of the comparative states, and for the United States as a whole.

TABLE XVI – 21

FEDERAL AND STATE HIGHWAY EMPLOYMENT IN THE UNITED STATES, 1950

	Construction					
	*With Federal Funds**	*State Funds*	*Total*	*Maintenance*	*Engineering. Supervision and Admin.*	*Total*
Iowa	1,449	771	2,220	1,567	818	4,605
Kansas	1,558	540	2,098	1,816	748	4,662
Ohio	1,841	768	2,609	4,870	2,215	9,694
California	2,370	1,863	4,233	2,903	3,999	11,135
South Dakota	662	24	686	721	463	1,870
Entire US†	61,769	40,465	102,234	122,018	52,791	277,043

From Highway Statistics, 1950.

* On primary and secondary highways urban extensions.

† Does not include 3,214 employed on Federal Forest Roads, National Parks, etc., nor the construction contractors' forces.

4. CONCLUSIONS

On the basis of the experience gained in many countries where modern methods of mechanical highway maintenance are being used successfully and with low costs; the demonstrated inadequacies of the traditional hand methods, as used in Burma; and the magnitude of the endeavor of rehabilitating an entire highway system to meet the demands of current and expanding traffic; it is recommended that:

(*a*) Modern maintenance methods be adopted in all parts of the Union, using mechanical equipment for the major operations.

(*b*) Training and instruction programs in the use of the equipment be instituted at an early date to furnish competent operators. The instruction techniques should take advantage of all known modern methods of imparting industrial instruction in order that the best possible result be obtained.

J. MATERIALS AND TESTING LABORATORY, SHOPS

1. LABORATORY

In the Preliminary Report it was recommended that a modern laboratory for testing the quality and suitability of local materials, for determining stabilization procedures, and for verifying the quality of imported materials, be established. It was also suggested that in addition to the central laboratory in Rangoon, branch laboratories in other parts of the Union might be required to avoid the delay of shipping materials to the central establishment.

The laboratory should also be equipped to test borrow pit and other subsurface materials. Mobile field units should also be provided to assist in the field explorations.

The laboratory, with trained and competent personnel, is an essential part of the expanded instruction program for the rehabilitation of the highways if durable and economical construction is to be realized.

2. SHOPS

It has also been proposed that a modern workshop be erected and equipped, partly with surplus material now available at the Mingaladon Airport shop. A tremendously expanded highway construction and maintenance program, such as will be necessary to rehabilitate the highways of Burma, will also require expanded shop facilities. As a first step in the program, the shop would serve as a training center for mechanics, welders and machinists. The shop should also include warehousing space and a stock of spare parts for the heavy equipment.

K. PLANNING AND SURVEYS

1. PROCEDURES

It appears from the annual Reports of the Department of Buildings and Roads, from its predecessor bodies, from other historical data, and from conferences and correspondence with the responsible officials in the Department, that the processes of planning and surveying for the integrated development of the highway systems are inadequate. The object of the highway rehabilitation program is the construction of a network of modern roads connecting all segments of the population. To accomplish this, the Department should be engaged in a continuous study of traffic and highway matters both within the Union and overseas, and should constantly re-examine its programs, adjust them, and replan them as necessary to meet the growing needs of traffic.

To carry out such a program it will be necessary to give special emphasis to planning and surveys as contrasted to the day-by-day operations of the Department in the carrying out of current programs. It is therefore recommended that a special group be set up within the Department charged solely with this function. The responsibilities, duties and administrative arrangements should conform to the following requirements:

The group should be administered by an Engineer of Plans and Programs under the direction of the Chief Engineer—Roads.

Operating under the supervision of the Engineer of Plans and Programs, the group should be responsible for (*a*) the orderly planning of improvements on the Union, district and farm-to-market road systems, (*b*) the programming and financing of such improvements and (*c*) the programming and financing of advanced engineering studies and negotiating of agreements for such studies with other political subdivisions or engineering organizations.

Personnel of the planning group, in addition to the Engineer of Plans and Programs, should include office engineers, staff engineers, engineers assigned to special studies, supervisors, statisticians, analysts, auditors, draftsmen and the necessary secretarial and clerical help.

The group should be composed of four sections; namely,

a. Planning Survey Section

This section is concerned with the gathering, analyzing, and reporting of research and statistical information from the field, and traffic, road inventory and physical matters in general.

b. Planning Section

The functions of this section are the classification of all highways; the preparation of sufficiency ratings for highway sections, classified by systems; the development of long-range planning and improvement programs; and the preparation of instructions and data to be used by other departments, circles and divisions.

c. Program Section

The functions of this section are essentially the programming and financing of construction projects, to maintain control of all funds used in planning for and the construction of highway improvements, and to act as the coordinating agency on all matters pertaining to the programming and financing of projects on all parts of the system.

d. Crossing Section

This section should study conditions at crossings and intersections, should advise the Engineer of Plans and Programs of dangerous or otherwise unsatisfactory situations, and should recommend needed improvements. It should also act as the coordinating agency with Burma Railways. This work should include such matters as traffic control studies, intersection layouts, railroad grade crossings, underpasses and overpasses.

e. Special Assignments

The following work may be performed by engineers on special assignment under the Engineer of Plans and Programs:

(1) Developing technical data for long-range planning.

(2) Conducting research work pertaining to special studies.

(3) Making field inspections and reports on selected projects to be considered for programming.

(4) Contacting division and other highway offices on matters pertaining to planning and programming.

(5) Performing other assigned duties.

2. RECOMMENDATIONS

Prior to planning, much survey work will be required:

(*a*) Aerial mapping and photogrammetry.

(*b*) Location and mapping of major sources of inexpensive aggregates, for use in the rehabilitation and maintenance programs.

(*c*) Traffic studies.

(*d*) Soils stabilization.

(*e*) Detailed construction survey.

(*f*) A financial study to discover the best method of financing the local highway improvements should be undertaken.

One of the most effective highway planning organizations devised in the United States is that for the Department of Highways of the State of Ohio. Data on its administrative arrangements have been furnished to the Department of Buildings and Roads as a possible aid in planning the attack on this phase of its long-range problems.

L. HIGHWAY ADMINISTRATION

The general administrative organization of the Department of Buildings and Roads has been fully described in the Preliminary Report. It is sound, and was well adapted to the procedures for which it was established.

However, in view of the recommendations as to basic changes to be made in the Department operations, as outlined elsewhere in the Report, certain administrative changes will be necessary to adapt the organization to its newly prescribed functions. The changes, including the basic modification in which a planning and programming group is established, yield the proposed organization shown on Plate C. The proposals for the plans and program organization were described in detail in Section K.

The suggestion that the existing department be subdivided to establish a separate Department of Traffic Control is highly recommended. Consideration should also be given to the possible desirability of incorporating some or all of the functions of the Department of Highways in the proposed new Ministry of Engineering Services referred to in Chapter XXV.

M. HIGHWAY FINANCING

1. HISTORICAL

In the United States, the financing of highways has progressively developed in three directions.

(a) Originally when there were few, if any, motor vehicles, roads and streets were local facilities and paid for entirely by local taxation. While still a prime source of revenue for local streets and for township and country road systems, local property taxation has decreased in importance for the primary and state highway systems, and in part, the cost of the local roads and streets is being met by the shares of the state-collected transport revenue distributed to the local units of government.

(b) As higher types of street and road construction and surfaces became necessary, it became common to issue revenue bonds to pay for the cost of such improvements. This practice was especially prevalent between 1900 and 1920. As the use of vehicles increased by leaps and bounds, it often became necessary to replace the pavement before the life of the bonds had run out, and the imposition of the cost of a second bond issue, and in some instances a third, caused an intolerable tax burden to a great many municipalities and county governments. This occurred at a time when expanded funds were needed to construct other streets and roads to meet the demands of increasing traffic.

(c) At the present time, the principal sources of state revenue for highway construction and maintenance are the special taxes and fees paid by motor vehicle users. These include motor vehicle taxes, motor vehicle registration and corollary fees, and special taxes applied only to motor carriers. Other sources, though less important, are property, sales and other taxes levied upon and paid by the general public. As described in later paragraphs, the Federal Government instituted in 1919 the so-called Federal Aid System, by means of which it also carries a share of the cost of the highways.

In 1950, the special imposts on highway users accounted for almost 2·6 billion dollars of revenue, nearly three fourths of the state and federal funds applicable to highways. Only about half of this income, however, was applied to state highway improvements and repairs. The remainder was used for local streets and roads, for non-highway purposes and for the costs of tax collection. The distribution of these funds, with the collection costs deducted, was as follows:

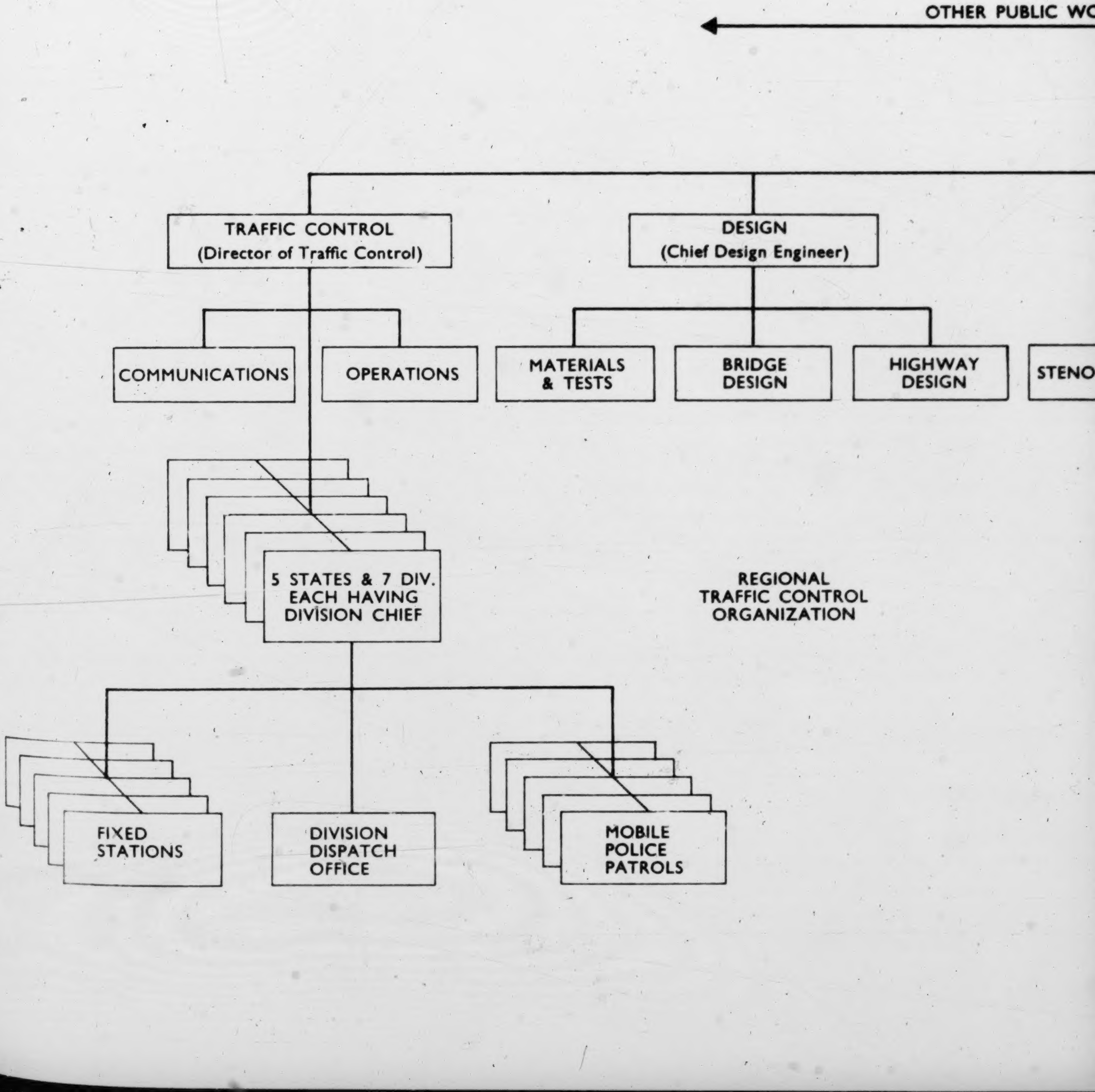
	Millions of $	*Per cent*
Construction of state highways	801	32
Maintenance and administration of state highways	586	24
Other state highway purposes	211	8
Local roads and streets	672	27
Non-highway purposes	217	9
Total	2,487	100

The state-collected revenues from motor vehicle users are distributed to the local government units in a variety of ways, but are reserved for the purposes of aiding and financing the necessary street and highway construction and maintenance by cities, towns and counties. This is usually done by formula, considering the population, highway mileage and vehicle registration within the several units.

Of the total state revenues collected, the sources and proportions were as follows:

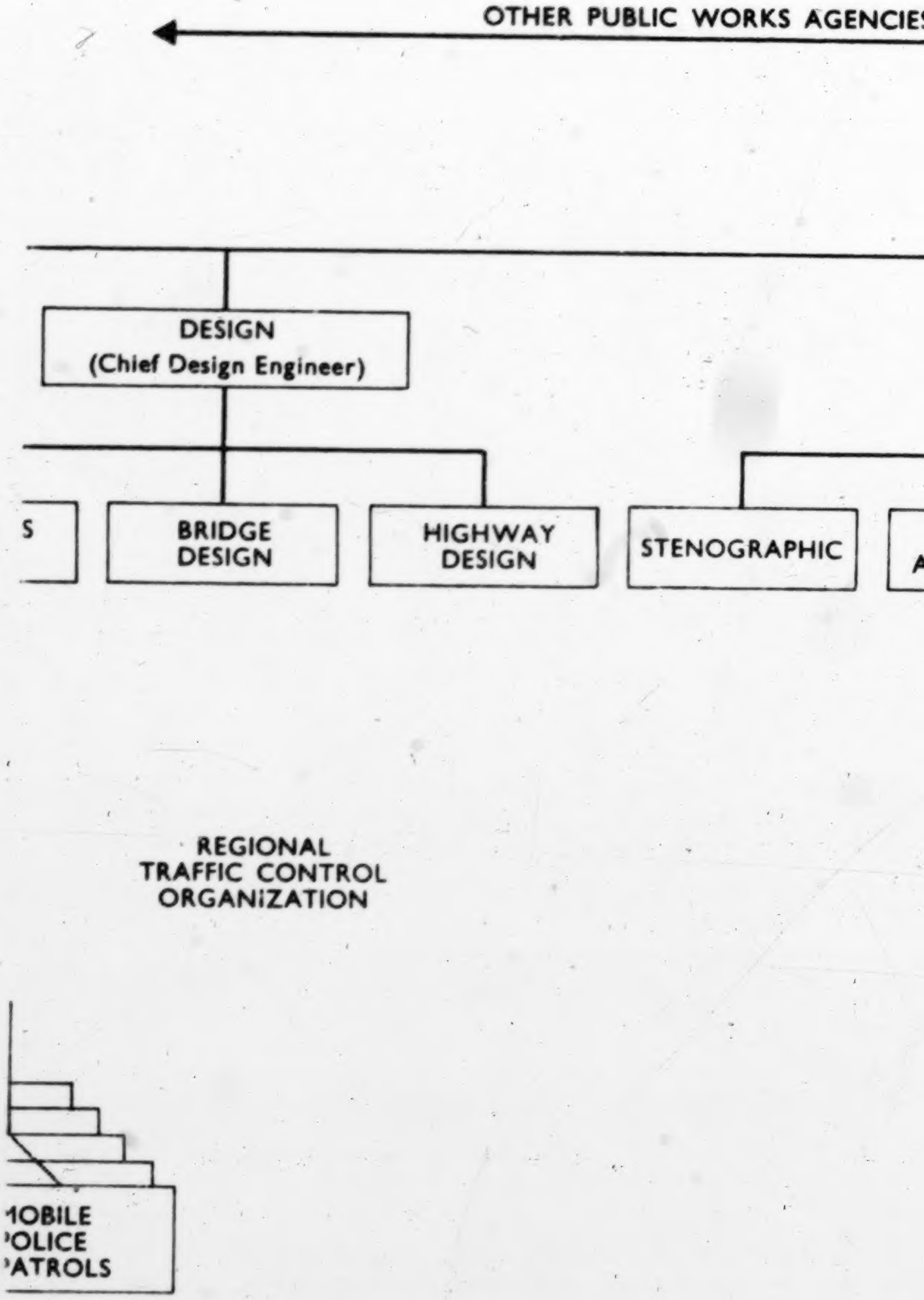
State taxes		
Fuel tax	46%	
Vehicle fees	25%	
Motor carriers	1%	
General funds	1%	
		73%
Road, bridge and ferry tolls		2%
Federal aid funds		12%
Bond revenue		11%
Miscellaneous		2%
		100%

It will be noted that the fuel tax, which in the US is commonly called the "gas tax," is the largest single source of state tax revenue, and produces nearly half of the total state revenues for highway purposes. In the states of the United States the collection of this tax is generally in the hands of the State Treasurer, or the Commissioner of Revenue and Taxation, or some similar office. In most cases, this actual detailed responsibility is with a special group, often called the Motor Fuels Tax Division. Generally, the tax is levied only against gasoline used for highway purposes. Such non-highway users as airplanes, marine craft, and agricultural machinery are tax-free. At present, the



OTHER PUBLIC WO
TRAFFIC CONTROL (Director of Traffic Control)
DESIGN (Chief Design Engineer)
COMMUNICATIONS
OPERATIONS
MATERIALS & TESTS
BRIDGE DESIGN
HIGHWAY DESIGN
STENO
5 STATES & 7 DIV. EACH HAVING DIVISION CHIEF
FIXED STATIONS
DIVISION DISPATCH OFFICE
MOBILE POLICE PATROLS

REGIONAL
TRAFFIC CONTROL
ORGANIZATION


OTHER PUBLIC WORKS AGENCIE
DESIGN
(Chief Design Engineer)
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BRIDGE DESIGN
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REGIONAL TRAFFIC CONTROL ORGANIZATION
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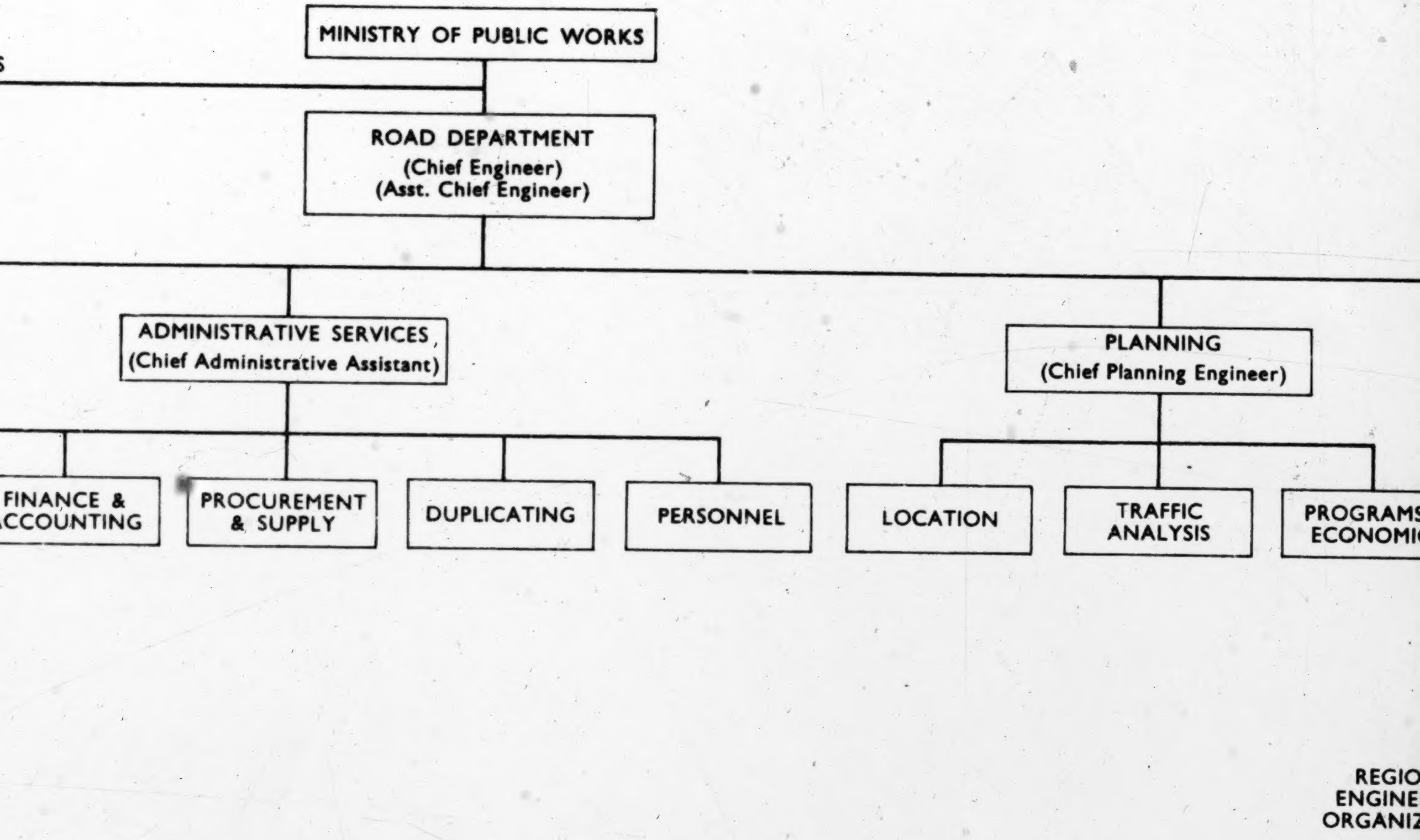
SUGGESTED ORGANIZATION CHART
FOR
THE HIGHWAY DEPARTMENT OF BURMA



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MINISTRY OF PUBLIC WORKS

ROAD DEPARTMENT
(Chief Engineer)
(Asst. Chief Engineer)

ADMINISTRATIVE SERVICES
(Chief Administrative Assistant)

FINANCE &
CCOUNTING

PROCUREMENT
& SUPPLY

DUPLICATING

PERSONNEL

PLANNING
(Chief Planning Engineer)

LOCATION

TRAFFIC
ANALYSIS

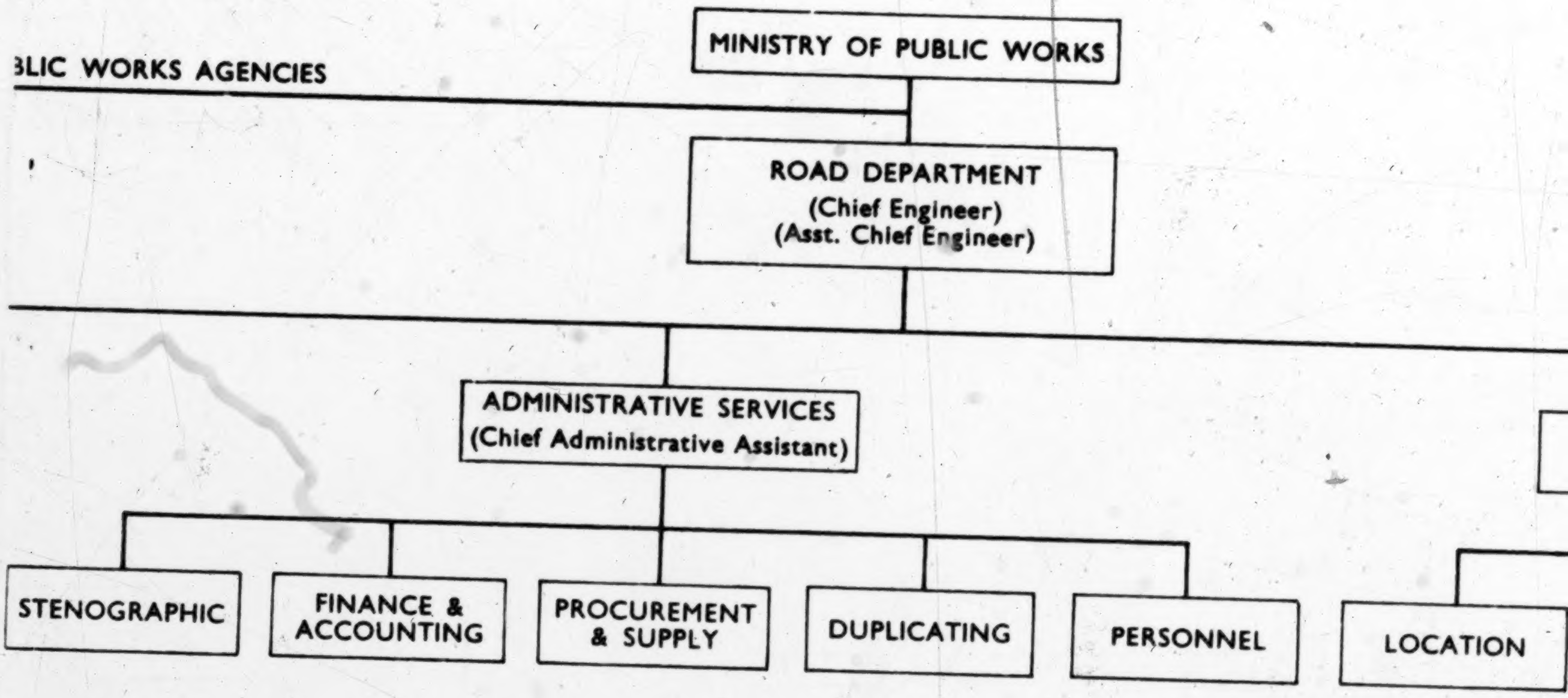
PROGRAMS
ECONOMI

REGIO
ENGINE
ORGANIZ

E: THE REGIONAL TRAFFIC CONTROL AND ENGINEERING ORGANIZATIONS APPLY TO EACH OF THE FIVE STATES AND SEVEN DIVISIONS OF THE UNION OF BURMA.

REV. 1

SUGGESTED ORGANIZATION CHART
FOR
THE HIGHWAY DEPARTMENT OF BURMA



MINISTRY OF PUBLIC WORKS

BLIC WORKS AGENCIES

ROAD DEPARTMENT
(Chief Engineer)
(Asst. Chief Engineer)

ADMINISTRATIVE SERVICES
(Chief Administrative Assistant)

STENOGRAPHIC

FINANCE & ACCOUNTING

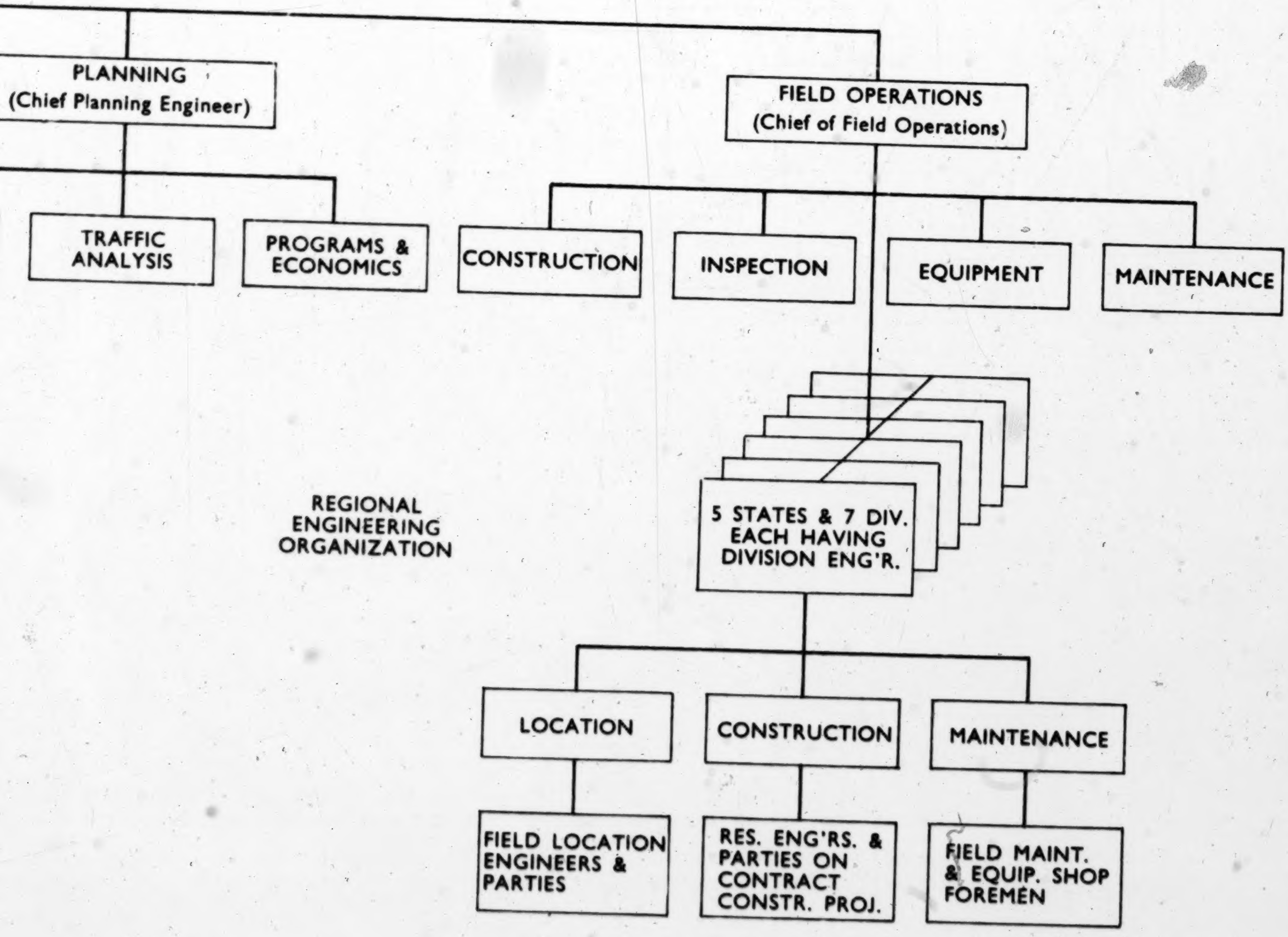
PROCUREMENT & SUPPLY

DUPLICATING

PERSONNEL

LOCATION

NOTE: THE REGIONAL TRAFFIC CONTROL AND ENGINEERING ORGANIZATIONS APPLY TO EACH OF THE FIVE STATES AND SEVEN DIVISIONS OF THE UNION OF BURMA.


PLANNING
(Chief Planning Engineer)
FIELD OPERATIONS
(Chief of Field Operations)
TRAFFIC ANALYSIS
PROGRAMS & ECONOMICS
CONSTRUCTION
INSPECTION
EQUIPMENT
MAINTENANCE
REGIONAL ENGINEERING ORGANIZATION
5 STATES & 7 DIV. EACH HAVING DIVISION ENG'R.
LOCATION
CONSTRUCTION
MAINTENANCE
FIELD LOCATION ENGINEERS & PARTIES
RES. ENG'RS. & PARTIES ON CONTRACT CONSTR. PROJ.
FIELD MAINT. & EQUIP. SHOP FOREMEN

REV. 18/1/54

PLATE NO. C

price of gasoline varies in the several parts of the US, depending upon transport charges from the refinery to the point of retail distribution, but is in the range of 21-24 cents per US gallon. To this is added the tax, for which typical state levies are as follows:

	Cents per gallon
California	4·5
Iowa	4
Kansas	5
Ohio	4
South Dakota	5
Average for all states	3·48

It has been found necessary, from time to time, to review the tax in the light of current economic conditions, especially highway costs which are often a rough barometer of business levels, and to determine whether the tax rate is such that sufficient revenue is produced to enable the various highway bodies to carry out an adequate program of construction and maintenance.

2. FEDERAL AID

Since it offers a reasonable pattern for the similar distribution of government funds to local units for highway funds in Burma, a brief review of the so-called Federal Aid system in the United States follows.

The procedure was initiated in 1916 with the first authorization of the primary system. Funds were divided between the states on the basis of population factors and highway mileage on the designated system. The authorizations by Congress under the Federal Aid Act for the years 1917–53 are shown on Plate 12. It will be observed that for the period 1917–33, the authorization tended to average approximately 100 million dollars per year. During 1935–45, except for the dislocations of the war years, about 150 million dollars per year were authorized, and since the end of the war the figure has been 450 to 500 million dollars per year. This latter increase is due in part to the need to do the work that was deferred during 1940–45, but also reflects the phenomenal increase in motor traffic since the end of hostilities.

The Federal Aid highway system consists of about 235,000 miles of rural roads and city streets selected and incorporated into the network jointly by the states and the Federal Government. The mileage is almost entirely on state systems and is thus part of, and not in addition to, United States mileages reported in Section E. As of June 1951, the Federal Aid secondary system consisted of 417,000 miles of highway, with 45% being in state systems and the remainder in county or other local systems.

The Federal Aid system, like many other American governmental agencies and procedures, represents gradual growth and experience. As early as 1891, for example, New Jersey, one of the states in the United States, had established a State Aid Act to assist counties, townships, and local communities in the construction and maintenance of local highways. By 1917, when the Federal Aid Act was enacted by Congress, all of the 48 states had established, in some form, a similar system. Incidentally, each by then had also established and was operating a separate state highway department charged with road construction and maintenance.

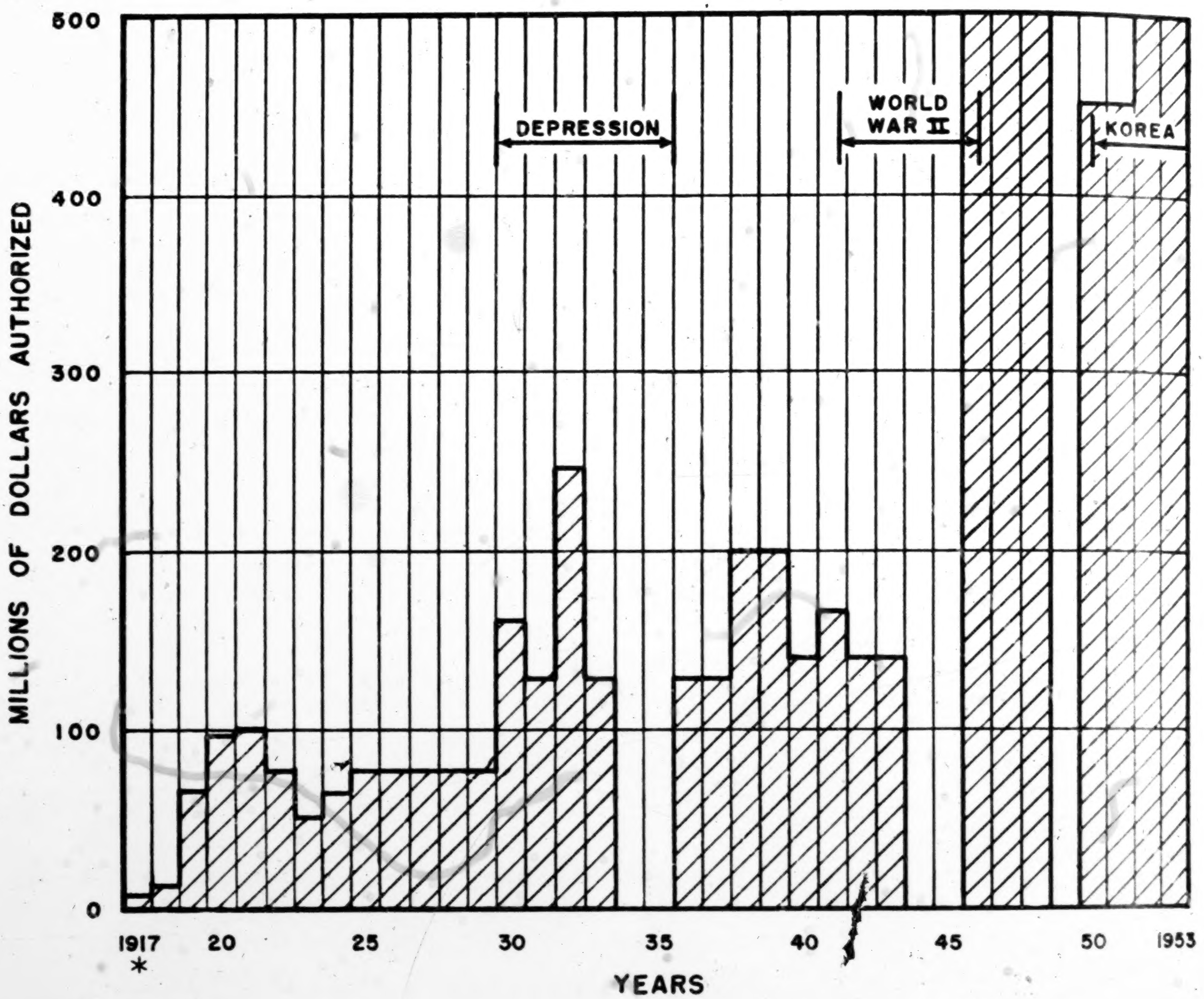
Another valuable characteristic of the Federal Aid system is that while apportionments are made each year to the states, considerable flexibility is allowed in expending the funds. This allows the states to have orderly planning and budgeting of their funds.

Federal funds are available for expenditure only on the designated Federal Aid systems, and in general must be matched by an equal amount of state or local funds. Federal aid may not be expended for maintenance nor for land acquisition. The cost of most Federal Aid projects is paid initially out of state highway funds, or in some cases by counties or other local governments. The Federal share is paid as reimbursement to the states as the work progresses, with final payment made upon completion.

3. HIGHWAY FINANCING, BURMA

At present the construction, repair, and maintenance of the national and primary roads are financed by allotments from the general revenue of the Government of the Union based upon decisions reached by Parliament. For repairs, the Department of Buildings and Roads submits annual budgetary requests which, when incorporated in the general budget for the Ministry of Public Works, are also acted upon by Parliament.

District roads are the responsibility of the district councils. The streets in the municipalities are also a local responsibility, except that where the national and primary roads traverse the communities, these sections of highway remain under the jurisdiction of the Department. The district local fund boards administer funds applicable to town streets. The various local fund bodies often have no trained personnel and working crews for the execution of highway work, and the department staff is partially used in these situations, the projects being performed as deposit works. Also, the municipalities, district councils and local fund boards exercise control over very minor total expenditures. The local bodies generally have to maintain and repair the district roads and town and city streets with moneys obtained from local taxation and occasional grants from the Government.



* Federal Aid Enacted

Note:

Special appropriations for Public Works Administration Highways (1933-35) and Defense Highways (1942-44 and 1951-52) not included in totals.

MINISTRY OF NATIONAL PLANNING

HIGHWAYS

TOTAL FEDERAL AID U.S. HIGHWAYS 1917-1953

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P. DATE PLATE
CK. BY K.B.W. MAY, 53 NO. 12

While the local bodies have the right to levy any taxation that is necessary, the fear has grown up that it is unwise to raise this part of the tax burden, since it would greatly increase the total tax burden. This is an unsound position. Additional funds must be secured from either local or national sources to permit adequate highway maintenance and repair to be carried out, and to engage in a long-range well-planned highway development program. This can best be done by greater budgetary allowances for highway programs. The Department, reorganized along the lines suggested elsewhere in this Report and enlarged to cope with an enlarged program, is the proper agency to handle the national, the secondary and certain of the urban highways. The staff must employ a greater degree and wider variety of specialized training and skills, in order that the entire network of highways may be brought to not only its prewar condition but to the advanced state required to meet the challenge of present and developing traffic conditions.

There are other special-purpose roads, such as those serving irrigation projects and forest areas. These are not public routes and are therefore the responsibility of the several departments in question, rather than of Buildings and Roads, and funds for these special-purpose roads are derived from the several departmental budgets.

4. CONCLUSIONS

Considering the inadequacies of both local funds and the facilities of the Department of Buildings and Roads, it is concluded that:

(*a*) A modern local-aid system should be established. Funds from national sources, in sufficient amount to do an adequate job, must be furnished. It is even more important that the local road bodies be assisted by the Department to assume more and more of the problem of local road administration, maintenance, repair and construction as they progress.

(*b*) That a pattern, adapted from the United States Federal Aid secondary system, should be used as a guide in developing a system for Burma.

(*c*) That at present the motor traffic is of such volume that the revenue produced from a tax on gasoline used in motor vehicles would produce inadequate funds for the necessary maintenance and construction program. At present, the preferable source for the major part of the funds needed should be the general funds of the Union, distributed to the districts and communities in proportion to their highway needs. Some part of the funds should be on a share and share basis, so that the local body also makes a contribution to the development of its parts of the highway system. Other funds can be, as now, on a grant basis. Later, as traffic develops, it probably will become expedient and desirable to use a gasoline tax, or some similar special-purpose levy, as a source of highway revenue.

(*d*) That the present system of licensing of vehicles should be continued, with the fees modified to conform to the recommended Motor Vehicle Code outlined in Section N of this chapter. It is essential that the control by taxation and licensing of vehicles using the highways be maintained in the interests of public safety to prevent overloading on the roadway pavements and structures and to insure continuance of the right to enforce traffic regulations.

With the enactment and use of the code, there will soon develop a sufficient body of experience as to vehicle characteristics such as weights and axle loads to enable the authority to establish a weight tax for the heavier vehicles using the highways. This is one way, and possibly the simplest and most equitable way, to establish the proportionate contribution to be made by different weights of vehicles to the cost of building and maintaining the highways.

(*e*) It should be kept in mind that transport by motor vehicles is only one aspect of the whole transport structure. While the road systems of the Union must be repaired, reconstructed and rehabilitated, and must grow with the growth of traffic, the whole network must be brought to and kept in its proper relationship with the other forms of transport (air, water and rail), to develop an integrated whole, a system which serves the entire Union with the maximum economic and social benefit.

N. HIGHWAY CODE

1. NEED FOR REVISION OF THE 1907 CODE

The basic legislation under which motor vehicle traffic now operates and is controlled in Burma is Burma Act No. V of 1907. This was passed in Council on March 14 that year, received the assent of the Governor-General on May 4, and was published and placed in effect on June 1, 1907. The Act is "In the regulation of traffic and the preservation of the surface of public roads and places in Burma."

Under it, the local government was empowered to make rules for traffic on public roads and places and for the preservation of the surface of such roads and places. These rules were to include, as major items, those which would (*a*) prohibit or restrict the use of vehicles causing damage or excessive wear to surface, (*b*) provide for licensing of drivers, (*c*) establish speed limits, (*d*) establish the rules of the road, (*e*) establish the requirements for mechanical features and equipment of vehicles, including lights, (*f*) establish weight and passenger limitations for vehicles, and (*g*) establish penalties for violations of any rule established under the Act.

Subsequently, and from time to time, the Public Works Department established and modified the Burma Road Rules; established left-hand driving as the rule of the road; established and modified a list of "notified roads" (upon which subsequently government funds could be expended); established a distinction in road administration and responsibility as between the Executive Engineer of the Public Works Department, representing the Government, and the Deputy Commissioner and Public Works staff of the districts, representing local government; established load, wheel and tire restrictions for vehicles (these became effective on October 1, 1909); gave power to the Public Works Department or the local deputy commissioner to close roads for repair with proper notice and establishment of detours for traffic; gave power to regulate traffic in the interest of preventing danger or injury to the public; and prohibited bullock carts from using the traveled surface of any road unless provided with springs.

With the introduction and widespread increase in the use of motor vehicles, and especially with the development of the handling of freight by truck, many of the provisions of the original law, and certain of the modifications and notifications thereunder are outmoded and should be modified. In special need of overhauling are those portions of the Act relating to animal traffic on the highways. For example, the rules promulgated under the law included one forbidding the travel or driving of elephants on any road unless the animal was provided with a bell or other audible warning signal. Also, any person in charge of an elephant was required to remove it from the road if requested to do so by any person leading, riding or driving an animal rendered restive by the presence of the elephant.

Also, the development in the use of motor transport of all kinds, which to a very large degree occurred during the war years, with the accompanying general increase in the speed at which vehicles operate, has brought about a new set of conditions for highway transport and traffic control. The highway code should at all times be flexible enough to accommodate itself to changes.

Further, as the use of highway transport develops, any law or code must anticipate changes in order to influence and guide the direction of development of motor transport for the maximum benefit to the public. For these reasons, because the present law cannot be effectively enforced, and because it is impractical to revise a basically outmoded law, a new Motor Vehicle Code has been prepared. The recommended Code, with the more important features developed in detail and the remainder in synopsis form, is included as Section N-5 of this chapter.

2. BASIC FEATURES OF RECOMMENDED CODE

The basic features incorporated in the Motor Vehicle Code recommended for Burma take into account the current state of motor transport in Burma; the reasonable trends which this transport may take in the foreseeable future; the present status of the national and local highway systems; the changes which will be brought about by the rehabilitation and modernization program; the design, use and capacity of modern motor vehicles; the need to live for some time with the problem created by the co-existence of slow-moving traffic, largely bullock carts, and fast-moving and heavy motor traffic. The more important features of the new code include:

(*a*) Provisions for the registration of motor vehicles in the categories of private cars, hiring cars, buses, private buses, trucks and special vehicles; the payment of fees therefor, and the issuance of licenses and certificates of registration.

(*b*) Provision for revenue licenses for commercial vehicles, such as hiring cars, buses, private buses, and trucks; the payment of fees therefor; and limiting operating conditions.

(*c*) Issuance of permits for bus services, including the requirements for the establishing of routes, procedure in connection with the granting of the permits, and permits for hiring car service, including the procedures in connection with the granting of permits. Anticipating changes in the nature of bus traffic or the shifting of traffic, the code provides for the combination of bus companies to whom permits have been granted in order that more economical operation and better service to the traveling public may result. It is further contemplated that bus services may be established and carried out by Burma Railways in connection with its own operations.

(**d**) Issuance of permits for truck service for hire, with the requirements necessary to exclude certain kinds of truck hauling; including the procedures in connection with the establishing of rates and granting of permits.

The Code envisions that Burma Railways may find it economical and desirable to establish feeder services, by truck, for its own operations, or to replace, in the future, short terminal positions of its lines with such services. For this reason, requirements and procedures are established for this purpose.

Since this section of the Code may well govern the development of commercial trucking, a very important segment of the transport facilities of Burma, and since this development, if carried out in an orderly and proper manner, will be of great help to the economic welfare of the nation and its people, great care should be taken in carrying out the objectives of this section. It is therefore recommended that there be created, as chief administrative officer, a commissioner of motor vehicles; that the registration of vehicles and related matters be handled by a registrar of motor vehicles; and that assistants and staff be established for each to effectively carry out, implement and enforce the code.

The responsibilities of the commissioner are enumerated in detail, and the relationship is established between his office and the Transport Commission, recommended elsewhere as the policy making and regulatory body for an integrated and complete transportation system for the Union of Burma.

(e) The establishment of offenses under the code and penalties therefor; and the development of correct procedures for handling offenses under the Code.

3. FLEXIBILITY IN CODE LIMITATIONS

All legislative acts, except those involving basic social concepts, must be so written as to admit changes in their requirements and limitations from time to time, as economic and social conditions progress. This is especially true where technologic improvements occur at a rapid rate.

The attempt has been made to provide a statute which meets the basic requirements of traffic, permits of the flexibility needed for changing conditions, is conveniently and fairly enforceable, and is reasonable in administration. Certain details must be developed in the operational procedures outlined in the Code, but these are administrative matters to be solved among the several government agencies involved. In doing this, the agencies should be guided by their own previous experience and the current practices of others. In this connection, the several states and government agencies in the United States have organized a quasi-official, but largely advisory group known as the American Association of Motor Vehicle Administration, to coordinate their efforts and to exchange information. It is believed that very good general data adaptable to local conditions and practices can be obtained from this organization.

In most cases in the recommended code, the basic limitations have been shown. Where final determinations are matters of local needs and experience, details have been left to the administrative agencies. This is especially true of the insurance requirements, and of the penalties to be levied for violations of the several parts of the Code. In the latter case, the basic principle should be that the severest penalties should be reserved for those offenses in which the danger to other persons, either in vehicles or as pedestrians, is the greatest.

In the assignment of effective dates for the several parts of the Code, care should be taken not to impose any real economic or other hardship on vehicle owners. For example, it is just to institute speed limitations or new registration procedures upon short notice, if enough time is allowed beyond the date of enactment to permit the necessary educational and publicity measures to be taken, the procedures to be developed and initially instituted, and (in the case of buses) the necessary rearrangement of schedules to be made. It is not reasonable, on the other hand, to establish new load or size limitations on such short notice, for the owners of the existing vehicles which would be illegal under the new limitations would be unable to operate their vehicles after the fixed date. Their equity would thus be unfairly destroyed. This kind of date should be set considerably in advance, with the added provision that new vehicles purchased in the interim period should meet the new requirements.

The fee schedules for registration and licenses should be so fixed as to impose no economic hardship upon individual drivers and owners of vehicles. The basic objective of licensing is to establish control over the ability of drivers in the interest of public safety, and in the case of larger and heavier vehicles to safeguard the public and to prevent the destruction of its collective property, the public highways of the nation. In the case of commercial vehicles, a further objective is to give, by the granting or withholding of licenses and permits, control over the quality and nature of service rendered by the carriers to the public.

In establishing the speed limits under the Code it may be wise, as has been found in a number of state and municipal vehicle codes in the United States, to establish no definite limit. Instead the Code will provide that "the vehicle must at all times be operated safely, and prudently, and not operated in a reckless and dangerous manner." Most such codes go on to say that if a vehicle is operated at a speed in excess of —— miles per hour, it is the responsibility of the operator to prove that he was not driving in a reckless and dangerous manner. In this way, it is possible for the enforcement agencies to secure court convictions against operators who are guilty of a wide range of offenses against public safety, but who would not have violated the rules as to speed. On the other hand, with the burden of proof on the operator, a strong deterrent against excessive speeds is established. Again, the relative penalties under the code and the manner in which the latter is enforced should be in the interest of the safety of the general public.

It is of vital importance that the weight and size limitations to be placed upon vehicles under the Code shall be definite, reasonable and easily enforceable. They should be realistic in terms of the design and capacities of modern motor vehicles, and capable of adjustment as motor vehicles undergo further development and change. Since grave and even tragic structural damage can occur to roadway surfaces and subgrades, as well as to structures if they are overloaded, the public interest and investment in the highway system of the nation demands that this portion of the Code be severely enforced.

Recent experiments on a heavy-duty highway in the United States, carefully constructed in recent years and to modern high standards, have indicated the real need of controlling axle weight on heavy vehicles, and especially dual axles. In a concrete pavement, for example, a 20% increase in the axle load, from 18,000 lbs. to 21,600 lbs., produced six times as many cracks as had existed in the pavement under continued applications of the lighter axle load. The damage to flexible pavements of the bituminous type such as are used in Burma would have been even greater.

It is therefore vital that clear-cut design standards be established for the roads of each classification, that construction be carefully carried out by the design capacities, and that the weight and axle requirements of the Code be strictly enforced.

4. COORDINATED TRANSPORT

One of the basic features of the new Code is that it envisages a coordinated system of transport in which each of the modes participates in the over-all system to the degree consistent with its basic usefulness, convenience and economy in order that the general public welfare be served to the maximum extent. The Code also establishes procedures for the consolidation of bus lines, if necessary, in order that more efficient service be rendered to the traveling public.

The relationship between the administration of the code and the Transport Commission is indicated in the Code. This relationship is more fully presented in Chapter X, Transportation.

5. PROPOSED MOTOR VEHICLE CODE

The draft of the recommended model Motor Vehicle Code, partly in detail and partly in synopsis form, is included herewith.

UNION OF BURMA
MOTOR VEHICLE CODE

ACT No. ——, 1954

Section

1 Enabling clause, with effective date and repealing all existing acts, by name.

PART I

REGISTRATION OF MOTOR VEHICLES

Section

I–1 Prohibition on possession or use of vehicles without registration.

I–2 (*a*) Requirement that registered vehicle comply with regulations promulgated under Code as to weight, dimensions and equipment for that class of vehicle.

(*b*) No motor vehicle shall be registered as a private car or a hiring car if the tare of that vehicle exceeds two and one-half tons.

I–3 (*a*) No motor bus shall be registered unless the person for the time being entitled to the possession of that motor bus is the holder of:

(1) A bus permit for a regular bus service; or

(2) A certificate of eligibility (granted under the Code) for bus permits for occasional bus services; or

(3) A private bus permit for that motor bus.

(*b*) No person shall be registered as the owner of a motor bus unless he is the holder of:

(1) A bus permit for a regular bus service; or

(2) A certificate of eligibility (granted under the Code) for bus permits for occasional bus services; or

(3) A private bus permit for that motor bus.

I–4 All motor trucks, tractors, trailers and special-purpose vehicles of the same nature now operat- or hereafter placed in operation upon the public highways should have placed on them data in respect to the vehicle height, width and length; kind and size of wheel and tire; unladen weight and carrying capacity as duly authorized by the Commissioner of Motor Traffic. This data shall be prominently painted, or otherwise permanently shown, on the vehicle.

I–5 to I–13 Requirements covering description of motor vehicle upon registration; keeping of register of vehicles by categories; application for registration; payment of registration fee; issuance of license and certificate of registration; data on vehicle to be furnished with application, including weight; detailed procedure on change of ownership, application and registration of new owner, cancellation or registration.

PART II

CONSTRUCTION AND EQUIPMENT OF MOTOR VEHICLES

II–1 Regulations may be made prescribing the requirements as to construction, weight, dimensions and equipment of motor vehicles as prescribed in Part VIII. Any such regulation may be expressed to be applicable to motor vehicles generally or to any specified class of motor vehicles.

II-2 Requirements as to number and position of license plates, shape thereof, etc.

PART III

REVENUE LICENSES

III-1 Legal requirements to prevent possession or ownership of motor vehicles without revenue license.

III-2 A revenue license to be issued under this Part for a motor vehicle shall be a license of one of the following descriptions, that is to say, a private car license, a hiring car license, a private bus license, a bus license, a truck license, a motorcycle license, a motor hearse license, a motor ambulance license, an invalid carriage license or a land vehicle license, and shall be issued having regard to the class of motor vehicles to which that vehicle belongs.

III-3 Requirement that the revenue license be not issued except on the production of the certificate of registration, and that of insurance or security.

III-4 (*a*) No bus license shall be issued under this Part except for a bus the registered owner of which is the holder of:

(1) A bus permit for a regular bus service;

(2) A certificate of eligibility (granted under the Code) for bus permits for occasional bus services.

(*b*) No private bus license shall be issued under this Part except for a private bus the registered owner of which is the holder of a private bus permit authorizing the use of that bus.

(*c*) No truck license shall be issued under this Part except for a truck the registered owner of which is the holder of a permit granted under the Code authorizing the use of that truck.

III-5 No revenue license for a hiring car, motor bus, truck, motor hearse or motor ambulance shall be issued by a licensing authority unless that car, bus, truck, hearse or ambulance, as the case may be, has, within the period of two months immediately preceding the date on which the license is to come into force, been examined and certified to be fit for use under all requirements of Part IX of the Code.

III-6 to III-10 Requirements as to form of application for revenue license; license fees, form and period of revenue licenses, including limitations on such periods; and the power to insert conditions in revenue licenses in the interest of safety.

III-11 (*a*) The licensing authority shall specify in every revenue license issued by the authority:

(1) for a private bus, the maximum number of persons authorized to be carried in that bus; and

(2) for a hiring car or a bus, the maximum number of passengers authorized to be carried in that car or bus, as the case may be, with limitations as to extra seats in the case of hiring cars, and limitations as to seating space, aisles, etc., for hiring cars, private buses, or buses.

III-12 The licensing authority shall specify in every revenue license for a truck issued by that authority the maximum load (that is to say, the payload) which may be carried on the truck. For the purpose of determining the maximum load, each person permitted to be carried on the truck shall be deemed to weigh one hundred and ten pounds.

III-13 Requirement that revenue license be carried on motor vehicle, and produced when required by court or the registrar.

III-14 to III-19 Requirements as to procedure when altering motor vehicle; surrender or cancellation of revenue license; issue of new revenue licenses with change in ownership; dealer's licenses and use of vehicles thereunder; temporary licenses; permission that Commissioner may issue permits for carriage of goods (with weight limitation stated) on private cars, carriage of mail or newspapers by hiring cars or buses; or for other purposes.

PART IV

PASSENGER VEHICLE PERMITS

Bus Services

IV-1 No bus shall, on or after the appointed date, be used on any highway except under the authority of a bus permit granted by the Commissioner under this Part and for the time being in force.

IV-2 Description of classes of bus permits, including those for occasional service.

IV-3 (*a*) The period for which a bus permit under this Part shall be in force shall:

(1) In the case of a permit for a regular service, be such period, not being less than two years nor more than ten years from the date on which it is expressed to come into force as shall be specified in the permit; and

(2) In the case of a permit for an occasional service, be such period as shall be specified in the permit.

IV-4 (*a*) Every application for a bus permit shall be made to the Commissioner in such form as the Commissioner may provide for the purpose.

(*b*) Every application for a bus permit for a regular service shall be made not less than three months before the date on which the applicant requires the permit to come into force.

(*c*) Every applicant for a bus permit shall submit together with his application a statement in such form as the Commissioner may provide for the purpose, containing:

(1) Particulars of the type or types of the buses proposed to be used under the permit;

(2) Particulars of the route or routes on which it is proposed to provide the service;

(3) In the case of a permit for a regular service, the timetable and fare-schedule of the proposed service;

(4) In the case of a permit for an occasional service, particulars of the area in which and of the event or events in connection with which a service is to be provided and such other particulars as the Commissioner may require including particulars relating to the frequency of the proposed service and the time to be taken on the journeys included therein;

(5) Such particulars as the Commissioner may require as to the hours of work or rest, hours of continuous duty, wages and other conditions of employment of the persons employed or proposed to be employed for the purpose of the service; and

(6) Such other particulars as the Commissioner may require.

IV–5 Publication of notice of application for permits for regular bus service; objections from others already furnishing service along or near the route, including Burma Railways; requiring public hearings on permit application.

IV–6 (*a*) Subject to the provisions of Section IV, the Commissioner shall have full power and discretion to make a determination either to grant or to refuse an application for a bus permit.

(*b*) The Commissioner, in exercising the discretion in regard to the grant or refusal of bus permits and to the route or routes in respect of which permits may be granted, shall have regard primarily to the interests of the public generally, including those of persons requiring as well as those of persons providing facilities for the transport of passengers for fee or reward and shall, in particular, have regard in the case of any application for any such permit, to the following matters:

(1) The extent to which the proposed service is necessary or desirable in the public interest;

(2) Suitability of the proposed route or routes;

(3) The extent, if any, to which the needs of the proposed route or routes are already adequately served;

(4) The needs of the area as a whole in relation to traffic (including the provision of adequate, suitable and efficient services and the provision of unremunerative services) and the coordination of all forms of passenger transport, including transport by railway;

(5) The question whether any provision or any other written law prescribing a speed limit is likely to be contravened;

(6) The financial position of the applicant, insofar as it may affect the efficient operation of the proposed service;

(7) The following considerations of policy, that is to say,

(i) That wherever any transportation facilities (including facilities provided by the railway) in any area or on any route are, in the opinion of the Commissioner, satisfactory and efficient to meet at reasonable charge the transportation requirements of the public within that area or on that route, it is desirable to grant bus permits authorizing the carriage of passengers within substantially the same area or over substantially the same route in competition with the said transportation facilities, and

(ii) That it is desirable, except where special circumstances render it inexpedient to do so, to give preference (other things being equal) to an application by a Cooperative Society for a permit to provide services which fulfill transportation requirements in the locality in which the society carries on its activities wherever such services will not be in competition with services provided on established trunk routes, and to give preference to an application by any Municipal Council for a permit to provide services on any route on which a bus service was provided in the month of ——, and

(iii) That, where in the case of any application for a bus permit authorizing the provision of a regular service the following condition is satisfied, namely, that the applicant is at the time of his application the holder of a permit authorizing the provision of a substantially similar service, preference should be given to the application over any application by a person in whose case the said condition is not satisfied, unless the refusal of the first-mentioned application is justified on the ground that the conditions of any permit previously held by the applicant have not been complied with or is justified by special circumstances.

IV–7 Subject to the provisions of this Code and of any regulations made in that behalf, the Commissioner may attach to any bus permit all such conditions as he may think fit to impose with respect to the matters mentioned in Section IV-6 and generally for securing the safety and convenience of the public, including conditions requiring:

(*a*) That the fares to be charged shall be such as may be specified in the permit.

(*b*) That the service shall be operated in accordance with a timetable specified in the permit.

(*c*) That copies of the timetable and fare-schedule shall be carried and kept exhibited in buses used on the service.

(*d*) That every bus used on the service shall be of a specified type and be maintained at all times in a fit and serviceable condition.

(*e*) That no bus shall be used on the service unless a certificate of fitness in respect thereof is in force for the time being.

(*f*) In a case where permits are issued to different persons involving the use of the same section of a highway, or where any route or part thereof lies within the administrative limits of any local authority, that passengers shall not be taken up or shall not be set down (i) except at specified points or (ii) between specified points.

(*g*) That the requirements of any written law with respect to the time for which drivers or conductors of buses may remain continuously on duty and to their hours of work or rest and to their wages are complied with in the case of the drivers and conductors of the buses used under the authority of the permit.

(*h*) That the speed limits prescribed by any written law and applicable in the case of buses shall be observed in the operation of the service.

(*i*) That mails or newspapers shall be carried to such places and at such times as the Commissioner may specify, if payment for such carriage is made in accordance with rates approved by the Commissioner, and in the case of mails, that they shall be carried in accordance with terms and arrangements approved by the Commissioner and embodied in a contract between the applicant and the proper postal authorities.

(*j*) That the holder of the permit must make adequate provision, whether by the setting apart of funds or in any other prescribed manner, for depreciation of buses, buildings and plants and for the purchase of new buses.

(*k*) That in the case of a permit for a regular service, the holder shall be bound, if required to do so, to provide bus services or hiring car services on any neighbouring route or routes in the area deemed by the Commissioner to be the area served by the regular service provided under the permit, whenever the Commissioner is of the opinion that such additional bus or hiring car services are necessary in the public interest.

IV-8 (*a*) For the purpose of meeting any increased demand for passenger transport, the Commissioner may by order direct the holder of a bus permit for a regular service to increase the frequency of the services provided under any permit, or to provide additional regular services, whether on the whole of the route or routes specified in the permit or on any such route or part thereof; and any service which is provided in compliance with the order shall be deemed for the purposes of this Part to be a service authorized by that permit. No such order shall be made unless the holder has first been given an opportunity to be heard.

IV-9 Provisions for revocation, suspension or transfer of permits; right of appeal from determinations of Commissioner, and notices thereunder, etc.

IV-10 Regulations may be made with respect to all or any of the following matters:

(*a*) The procedure on applications for, and the determination of, questions in connection with the grant, variation, suspension and revocation of bus permits, the fees payable in respect of such applications and permits, and the manner in which, whether in a lump sum or in installments, such fees shall be payable.

(*b*) The custody of permits under this Part, and their production, return and cancellation on expiration, suspension or revocation and the custody, production and return of documents and plates.

(*c*) The plates and marks to be carried on buses and the manner in which they are to be displayed.

(*d*) The records to be kept by holders of such permits in relation to the persons employed by such holder as drivers or conductors of buses and to the time of the commencement and cessation of work by such persons and the intervals of rest taken by them.

(*e*) The documents to be carried by drivers of buses and the particulars to be entered therein.

(*f*) The records to be kept in respect of the journeys performed by buses (in addition to the registers required by Part VIII).

(*g*) The preservation of records so kept, the inspection of such records by any authority specified in the regulation, and the production for the purposes of such inspection of such records on demand made by any such authority.

IV-11 Establishment of effective date.

IV-12 (*a*) The Minister and the Transport Commissioner may require the Commissioner to prepare and present a plan;

(1) For the amalgamation of any or all of the companies which are authorized under this Act to provide bus services in any area or on any routes specified by the Minister; or

(2) For the transfer to any one of such companies of the business previously authorized under this Act to be carried on by any other such company or companies in any area or on any routes so specified; or

(3) For the formation of a new company, and the transfer to it of the business previously authorized under this Act to be carried on by any

other company or companies in any area or on any routes so specified.

In this sub-section, "authorized" means authorized by a bus permit or two or more such permits.

Hiring Car Services

IV–13 Similar requirements for permits for hiring car services, carrying out applicable requirements of Sections IV–3 to IV–11, modified as necessary.

Private Bus Permits

IV–14 Outline generally similar requirements for the granting of permits for private buses, for the transport of school students and staff, etc.; for ground transport as a part of an airways operation, transport of employers' staff, etc. (including those of government departments or other public or local authority); or transport for any other prescribed purpose of that general nature.

IV–15 Regulations may be made for the purposes of carrying out or giving effect to the provisions of Section IV–15; and without prejudice to the generality of the powers hereinbefore conferred, any such regulation may provide:

(*a*) The particulars to be contained in applications for private bus permits, and the fees payable in respect thereof;

(*b*) For the conditions which shall or may be attached to such permits, the variation, modification or revision of conditions or the addition of new conditions;

(*c*) For the revocation or suspension of such permits;

(*d*) For the duration of such permits, and

(*e*) The plates and marks to be carried on private buses and the manner in which they are to be displayed.

PART V

GOODS TRUCK PERMITS

V–1 No truck shall, on or after the appointed date, be used on any highway except under the authority of a permit granted by the Commissioner under this Part and for the time being in force, except trucks being operated under a dealer's license or trailers drawn by passenger cars.

V–2 A permit authorizing the use of a truck shall be one of the following classes, that is to say:

(*a*) A public carrier's permit; and

(*b*) A private carrier's permit.

V–3 (*a*) A public carrier's permit shall entitle the holder thereof to use trucks specified in the permit (hereinafter referred to as "the authorized trucks"):

(1) For the carriage of goods for fee or reward, and

(2) For the carriage of goods for or in connection with his business as a carrier of goods, whether by road transport or any other means of transport, and for such storage or warehousing of goods as may be incidental to his business as a carrier; and

(3) In the case of a permit held by a person carrying on a canal, dock or harbor undertaking, for the carriage of goods for or in connection with that undertaking.

(*b*) A private carrier's permit shall entitle the holder thereof to use the trucks specified in the permit (hereinafter referred to as "the authorized trucks") for the carriage of goods, otherwise than for fee or reward:

(1) For or in connection with any trade or business carried on by him and specified in the permit; or

(2) For any other purpose so specified.

(*c*) The carriage of goods by a person engaged in any trade or business, in any case mentioned in any of the following paragraphs shall not be deemed to be carriage for fee or reward:

(1) The delivery or collection, by that person, of goods sold, used or let on hire or hire-purchase in the course of that trade or business;

(2) The delivery or collection by that person of goods which have been, or are to be, subjected to a process of treatment or manufacture in the course of that trade or business.

(3) Where that trade or business is that of a manufacturer, agent or dealer in any goods, the carriage of goods for demonstration purposes in a truck;

(4) Where that person is a manufacturer of motor vehicles, the carriage of goods by him under and in accordance with regulations made in that behalf;

(5) Where that person is engaged in agriculture in any locality, the carriage by him of goods for or in connection with the business of agriculture carried on by any other person in the same locality;

and accordingly a private carrier's permit shall be sufficient to authorize any such carriage by that person.

(*d*) For the purposes of this Part of this Code the performance of its functions by any department of Government, or a local authority, or any prescribed public authority, shall be deemed to be the carrying on of a trade or business.

V–4 to V–6 Requirement for identification of authorized trucks under permits; restriction on use of authorized trucks; duration of permits (two and three years are suggested for public and private carriers, respectively), special permits for short term or special purposes.

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V-7 (*a*) Every application for a permit under this Part shall be made to the Commissioner.

(*b*) Every application for a permit under this Part for the current period shall be made not less than three months before the date on which the applicant requires the permit to come into force.

(*c*) Every applicant for a permit under this Part shall submit, together with his application, a statement in such form as the Commissioner may provide for the purpose:

(1) Containing such particulars as may be prescribed as respects the trucks proposed to be used under the permit;

(2) Furnishing particulars of the area (hereinafter referred to as "the proposed area of operation") in which it is proposed to carry goods under the authority of the permit;

(3) Specifying the place or places, if any, outside the proposed area of operation, between, or from, or to which it is proposed to carry goods under the authority of the permit and the route or routes to be used for such carriage; and

(4) In the case of an application for a public carrier's permit, specifying the facilities for the transport of goods intended to be provided for other persons under the authority of the permit.

(*d*) Every applicant for a permit under this Part shall furnish such other information as the Commissioner may reasonably require for the purposes of the consideration of the applicant and, in particular, an applicant for a public carrier's permit shall, if so required, submit in such form as the Commissioner may provide for the purpose:

(1) Such particulars as may be so required with respect to any business as a carrier of goods for fee or reward carried on by the applicant at any time before the making of the application and of the rates charged by him;

(2) Particulars of any agreement or arrangement, affecting in any material respect the provision, within the proposed area of operation, of facilities for the transport of goods for fee or reward, entered into by the applicant with any other person by whom such facilities are provided, whether within or without the area;

(3) Particulars of any financial interest (whether as a partner or as a shareholder or as a result of any loan, guarantee or other financial transaction) which any other person providing facilities for the transport of goods for fee or reward, or controlling (either solely or in conjunction with any other person) the business of any person who provides such facilities, has in the business of the applicant, and in the case of an applicant being a company, of any right which any such person as aforesaid has to nominate any director of the company.

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V-8 Special provisions, to permit or require use of extra trucks, to modify conditions of service as outlined in permit, advertisement and holding of public hearings on changes, etc.

V-9 (*a*) The Commissioner in exercising the discretion in regard to the grant or refusal of permits under this Part shall have regard primarily to the interest of the public generally, including those of persons requiring as well as those of persons providing facilities for transport of goods; and shall, as far as may be, be guided by the following considerations of policy, that is to say:

(1) That, wherever any transportation facilities (including facilities provided by the Railway) in any area or over any route are, in the opinion of the Commissioner, satisfactory and efficient to meet at minimum charge the transportation requirements of the public within that area or along that route, it is undesirable to grant permits under this Part authorizing the carriage of goods within substantially the same area or along substantially the same route in competition with the said transportation facilities; except that as between highway carriers, fair competition should be encouraged.

V-10 (*a*) It shall be a condition of every permit under this Part:

(1) That every authorized truck shall be maintained at all times in a fit and serviceable condition;

(2) That the requirements for any written law with respect to the time for which drivers of trucks may remain continuously on duty and to their hours of work or rest and to their wages are complied with in the case of the drivers of the authorized trucks;

(3) That the provisions of any written law with respect to speed limits, tare, laden weight and loading of trucks are complied with in relation to the authorized trucks; and

(4) That the provisions of any regulation made under this Part relating to the keeping of records, the carriage of documents, and the production and inspection of such records and documents, are complied with.

(*b*) The Commissioner may attach to any permit under this Part all such conditions he may think fit to impose in the public interest and with a view to preventing uneconomic competition, including conditions requiring:

(1) That the authorized trucks shall be used only in such area or between such places as may be specified in the permit;

(2) That the authorized trucks shall not be used in such area or between such places as may be specified in the permit;

(3) That the goods carried in the authorized

trucks shall be restricted to such classes or descriptions of goods as may be specified in the permit;

(4) That such classes or descriptions of goods as may be specified in the permit shall not be carried in the authorized trucks;

(5) That goods shall be carried in the authorized trucks only for such persons as may be specified in the permit;

(6) That the charges to be made for the carriage of goods shall not exceed or be less than such maximum or minimum charges respectively as may be specified in the permit;

(7) That the maximum laden weight of any authorized truck shall not exceed such weight as may be specified in the permit;

(8) That a speed-governor shall be fitted to any authorized truck; and

(9) That the maximum payload to be carried in each authorized truck shall not exceed such amount as may be specified in the permit.

V–11 Procedures for variation in conditions of permits; variations as to authorized trucks; revocation, cancellation, transfer, etc., of permits; etc.

V–12 (*a*) Regulations may be made with respect to all or any of the following matters:

(1) The procedure on application forms and the determination of questions in connection with the grant, variation, suspension and revocation of permits under this Part, the fees payable in respect of such applications and permits, and manner in which, whether in a lump sum or installments, such fees shall be payable.

(2) The means by which authorized trucks are to be identified, whether by plates, marks, distinctive colours or otherwise;

(3) The custody of permits under this Part, and their production, return and cancellation on expiration, suspension or revocation, and the custody, production and return of documents and plates;

(4) The notification to the Commissioner of trucks which have ceased to be used under permits;

(5) The records to be kept by holders of permits under this Part in relation to the persons employed by such holders as drivers of authorized trucks and to the times of the commencement and cessation of work by such persons and the intervals of rest taken by them, including records in relation to any such holder when acting as the driver of any authorized truck;

(6) The documents to be carried by drivers of authorized trucks and the particulars to be entered therein;

(7) The records to be kept, showing as respects every journey of an authorized truck, particulars of the journey, of the greatest weight of goods carried by the truck at any one time during the period to which the records relate and the description, points of loading and destination of the goods carried;

(8) The preservation of records so kept, the inspection of such records by any authority specified in the regulation, and the production for the purposes of inspection of such records on demand made by any such authority;

(9) The grant of exemptions either generally or in relation to particular persons or trucks from all or any of the requirements imposed by regulations made under paragraphs (5) to (8) and the circumstances in which and the conditions subject to which such exemptions may be granted.

PART VI

INSURANCE AND THIRD-PARTY RISKS

VI–1 Requirement that users of motor vehicles be insured or secured against third-party risks.

VI–2 Requirements as to policies.

VI–3 Requirements as to security.

VI–4 Production of certificates of insurance or security upon application for revenue licenses.

VI–5 Insurance requirements and procedures.

VI–6 Corresponding requirements as to security.

VI–7 Regulations as to form of application, certificates, records.

PART VII

DRIVING LICENSES

VII–1 For the purposes of this Part, motor vehicles shall be deemed to be divided into the following classes, that is to say:

(*a*) Motor buses.

(*b*) Trucks, and, in addition, motor ambulances and motor hearses.

(*c*) Hiring cars.

(*d*) Motor cycles.

(*e*) Invalid carriages.

(*f*) Private cars, and motor vehicles not hereinbefore specified.

VII–2 (*a*) Subject to the provisions of subsection (*b*):

(1) No person shall drive a motor vehicle of any class on a highway unless he is the holder of an effective driving license which is valid for motor vehicles of that class; and

(2) No person shall employ any other person to drive a motor vehicle of any class on a

highway unless the person so employed is the holder of an effective driving license which is valid for motor vehicles of that class.

(*b*) Conditions as to learner's permit, and operation of vehicle by person having such permit.

VII-3 Requirements as to application for driving license, fee, knowledge of mechanism and its operation.

VII-4 Insurance of license, duration of same (an effective period of one year is recommended, with renewal required), temporary licenses, etc.: cancellation, suspension, etc., of licenses.

VII-5 Special requirements for licenses to drive hiring cars, motor buses, trucks, with classes of licenses for several types of vehicles.

VII-6 Provision for participation in international licensing conventions; extension of reciprocity to holders of foreign licenses; tourist licenses or permits.

PART VIII

USE OF MOTOR VEHICLES ON HIGHWAYS

Speed Limits

VIII-1 (*a*) A motor bus or a truck having a tare exceeding one ton, shall not be driven:

(1) On any highway within an urban area, at a greater speed than 20 miles per hour, or

(2) On any highway outside an urban area, at a greater speed than 25 miles per hour.

(*b*) No motor vehicle having a total weight in excess of six tons, including load, shall be operated upon the public highways at a speed in excess of five miles per hour when such vehicle is equipped with iron or steel tires, nor greater than ten miles per hour when equipped with tires of hard rubber, or other similar material.

(*c*) A motor vehicle of any class or description, to which subsection (*a*) does not apply, shall not be driven:

(1) On any highway within an urban area, at a greater speed than 30 miles per hour, or

(2) On any highway outside an urban area, at a greater speed than consistent with safety of passengers and public. Any speed in excess of 40 miles per hour shall be considered unsafe unless the contrary can be proved.

(*d*) Regulations may be made, as respects all highways in any specified area or any specified highway or part of a highway, prescribing for all motor vehicles or any specified class or description of motor vehicles or any specified motor vehicles, speed limits more stringent than the limits set out in above.

Size Limitations

VIII-2 (*a*) After ——, except as otherwise permitted hereunder, no motor vehicle shall be operated on the public highways of Burma whose over-all dimensions exceed the following:

(1) Width 8 feet.

(2) Height 12 feet.

(3) Single vehicle, length 25 feet.

(4) Tractor, semi-trailer 36 feet.

Weight Limitations

(*b*) After ——, except as otherwise permitted hereunder, no motor vehicle unit shall be operated on the public highways of Burma:

(1) Whose total weight, including load, exceeds —— tons, if a single vehicle; exceeds —— tons, if a multiple vehicle.

(2) Whose weight on any single axle, including load, exceeds —— tons.

Tire and Wheel Limitations

(*c*) After ——(the effective date of this Code), no truck, tractor, trailer, traction or hauling engine, road roller or any other motor vehicle shall operate upon or over the public highways of Burma, the fare of the wheels of which are fitted with flanges, ribs, clamps, cleats, lugs or spikes. This restriction should apply to all rings or flanges upon guiding or steering wheels on any such vehicle. In case of tractors, traction engines, road engines, or hauling engines which are equipped or provided with flanges, ribs, clamps, cleats, rings, or lugs, such shall be permitted to pass over certain highways provided that cleats are fastened upon all the wheels of such vehicles, not less than three inches wide and not more than one inch high, and so placed that not less than two cleats of each wheel shall touch the ground at all times, and the weight shall be the same on all parts of the said cleats. The foregoing regulations relating to flanges, ribs, clamps, cleats, rings or lugs shall not be applied to tractors and traction engines used solely for agricultural purposes and which do not operate upon the public highways. To meet exceptional and present cases, the following requirements shall be applied to tractors and traction engines: the guide band on the front wheels shall not be less than three inches in width, but no flanges, ribs, clamps, cleats, rings or lugs will be permitted upon the front wheels. The full set of cleats upon the rear wheels of the original design as furnished by the manufacturers with the vehicle must be used, and no rivet heads or bolt heads shall project, and the use of such tractors and traction engines for agricultural purposes shall not be allowed for hauling purposes, excepting the hauling of threshing and other agricultural equipment necessary for the use of the owner on his farm. This provision shall in no case relieve the owner of any tractor or traction engine from liability for damage to public roads from defective wheels or excessive loads.

(*d*) The tire of each wheel of a truck, tractor, trailer, traction engine or other motor vehicle shall be smooth, and the weight of such vehicle, including load, shall not exceed 800 lbs. per any inch of tire width.

Exceptions, Permits, Responsibility

(*e*) Motor vehicles or loads thereupon having any maximum dimensions or maximum weight in excess of those listed in subsections (*a*) or (*b*) above may secure from the Commissioner of Traffic, by proper application in writing, permission to operate over or upon the public highways under such restrictions and safeguards as the Commissioner may prescribe. The owner, driver, operator or mover of any vehicle over any public highway shall be responsible for all damages which the said highway, or any structure on any other part thereof, may sustain as a result of violation of any of the provisions of the foregoing rules, regulations and requirements. The amount of such damages shall be determined by the executive engineer in charge of the section of the road concerned and his decision should be final and binding on all the parties, and the same may be recoverable in an action of tort, against the party concerned, by the Commissioner of ——, or any PWD officer nominated by him for the purpose.

It should be specifically provided as part of the Road Rules, that any violation of any of the foregoing rules, regulations and requirements shall be punishable by a fine as established in Part XI. The amount of fine should not be confused with the sum of "Damages" payable by the party for his violation of the rules, regulations and requirements resulting in actual physical damage to the structure of the highway concerned.

VIII–3 (*a*) Regulations may be made:

(1) Declaring any specified highway outside Rangoon to be unsuitable for use by:

(i) Motor buses; or

(ii) Trucks having tare exceeding one and one half tons; or

(iii) Articulated vehicles, trailers or six-wheeled motor vehicles; or

(iv) Any other class or description of motor vehicles having a tare exceeding two and one quarter tons; and

(2) Prescribing the conditions of restrictions subject to which such motor vehicles may be used on such highway.

VIII–4 No motor vehicle shall be used on any highway unless it is in all respects in such a condition that

it will not cause or be likely to cause, danger to any person in the vehicle, or on the highway, or using the highway, or to any property on or adjoining the highway.

VIII–5 Detailed regulations as to lights on motor vehicles for urban and rural use.

Rules of the Road

VIII–6 (*a*) A motor vehicle meeting or being overtaken by other traffic shall be kept to the left or near side of the road.

(*b*) A motor vehicle being overtaken by other traffic shall be driven so as to allow such other traffic to pass it.

(*c*) A motor vehicle shall not be driven so as to overtake other traffic unless the driver of the vehicle has a clear and unobstructed view of the road ahead of him.

(*d*) A motor vehicle overtaking other traffic shall be kept on the right or off side of such other traffic.

(*e*)–(*f*) Requirements as to not causing obstructions on highway; requirements for right and left turns at intersections.

General Requirements

VIII–7 (*a*) No person shall drive a motor vehicle on a highway when he is under the influence of alcohol or any drug.

(*b*) No person shall drive a motor vehicle on a highway recklessly or in a dangerous manner or at a dangerous speed.

(*c*) No person shall drive a motor vehicle on a highway negligently or without reasonable consideration for other persons using the highway.

VIII–8 Signals by driver, with illustrations.

VIII–9
to
VIII–13 Regulations as to driving in reverse, use of horn, riding on outside of vehicles, number of front-seat passengers, use of motor cycles.

VIII–14 Detailed requirements as to action to be taken by driver, owner, passenger and police in case of accident.

VIII–15 Requiring that traffic directions and signals of police be obeyed.

VIII–16 (*a*) Subject to such regulations as may be made in that behalf under subsection (*b*), traffic signs and notices may be erected or exhibited on, or so as to be visible from any highway:

(1) By order of police officer not below the rank of superintendent in charge of district, for the purposes of any temporary regulation of traffic; or

(2) By order of the licensing authority of the area in which the highway is situated or, in the case of a highway in charge of the Public Works Department, by order of that Department:

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(i) For the purpose of regulating the movement of traffic or indicating the route to be followed by traffic, or for any other purpose relating to or connected with the use of motor vehicles on that highway; or

(ii) For the purpose of prohibiting, restricting or regulating traffic over any bridge, or any section of the highway which is in a dangerous condition or in course of repair, construction or reconstruction.

(*b*) Regulations may be made prescribing the size, color, type or form of traffic signs and notices, declaring the significance of such signs and notices, and restricting or regulating the erection and exhibition of such signs or notices for the purposes of this section.

VIII-17 Safety requirements as to filling of petrol tank.

VIII-18 Requirements as to stopping and parking on highways.

VIII-19 (*a*) Regulations may be made under this Code prescribing a highway code comprising such directions as may appear to the authority empowered to make such regulations to be proper for the guidance of persons using roads and including directions relating to the prohibiting, regulation and control of traffic.

(*b*) Regulations may be made under subsection (*a*) amending, varying, replacing, adding to or rescinding any of the provisions of Sections VIII-6 to VIII-18 of this Code.

VIII-20 (*a*) No person shall drive, or cause or permit any person employed by him or subject to his orders to drive any hiring car or motor coach or truck:

(1) For any continuous period of more than four and a half hours; or

(2) So that the driver has not at least ten consecutive hours for rest in any period of 24 hours calculated from the commencement of any period of driving.

(*b*) For the purposes of subsection (*a*), any two or more periods of time shall be deemed to be a continuous period, unless separated by an interval of not less than half an hour in which the driver is able to obtain rest and refreshment.

(*c*) The wages paid or payable by the owner of any hiring car or motor bus or truck to any person employed by him as the driver or the conductor thereof shall not be less than the minimum rate of wages prescribed in that behalf by regulation.

VIII-21 Prohibition against charges of excessive fares for hiring cars, buses, and prescribing methods for the recovery of such excess fares.

VIII-22 Requirements as to handling of "lost and found" property.

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VIII-23 Requirements as to offenses committed by carrying of excess passengers and of goods other than personal luggage, in hiring cars and buses.

VIII-24 Requirements as to keeping of time schedules for buses.

VIII-25 Requirements as to tickets, etc.

VIII-26 Requirements as to buses overtaking each other on highway.

VIII-27 Where the weight of goods found at any time on a truck on a highway exceeds the maximum loads specified on the revenue license for that truck, or where the distribution of the load is such as to cause danger, the driver of the truck shall, save as provided in Section XI-1, be guilty of an offense under this Code.

VIII-28 (*a*) Regulations may be made:

(1) Prohibiting, restricting or controlling the use of motor vehicles generally or any specified class or description of motor vehicles, as respects highways or the highways in any specified area or any specified highway or part of a highway;

(2) Prescribing any condition or requirement not expressly provided for in this Code, as to the construction and equipment and use of all or any specified class or description of motor vehicles;

(3) Prescribing the compulsory use of taxi meters complying with the prescribed requirements on hiring cars generally or on any specified class or description of hiring cars or on hiring cars used in any specified areas and providing for the regulation of the use and the inspection and testing of taxi meters;

(4) Prohibiting, restricting or regulating the carriage of petroleum or other fuel, acids and other explosive, dangerous, or offensive articles on motor buses;

(5) Providing for the licensing, supervision and control of conductors of buses and of ticket inspectors employed by owners of buses, for the revocation or suspension of such licenses and for the imposition and recovery of fees for such licenses;

(6) Prescribing the duties and regulating the conduct of drivers, conductors and ticket inspectors of hiring cars and buses;

(7) Prescribing the minimum educational or other qualifications required for the grant of conductors' licenses in respect of buses;

(8) Providing for endorsements to be made on such licenses on conviction of the holder thereof of any offense under this Code;

(9) Providing for the regulation and control of queues at stopping places for buses, the facilities to be provided at such stopping places and the charges to be made for the use of such facilities;

(10) Prescribing the use of stopping places or public stands for buses and restricting the halting or stopping of buses on all highways generally or on the highways in any specified area or any specified highways or part of a highway;

(11) Providing that badges be worn by drivers and conductors of hiring cars and buses;

(12) Providing for the regulation and control of the conduct of passengers in hiring cars and buses;

(13) As respects hiring cars or buses:

(i) Authorizing the removal from such cars or buses of persons committing a breach of any provision of this Code or of any regulation by the drivers or conductors thereof or by any police officer on the request of the drivers or conductors thereof;

(ii) Requiring passengers in such cars or buses who are reasonably suspected by the drivers or conductors thereof of contravening any provision of this Code or of any regulation to give their names and addresses to a police officer or to the drivers or conductors thereof on demand;

(iii) Requiring passengers in hiring cars or buses to declare, if so requested by the drivers or conductors thereof, the journey they intend to take or have taken, and to pay the fare for the whole of such journey and to accept tickets provided therefor;

(iv) Requiring, on demand being made for the purpose by the drivers or conductors of such cars or buses or by any other person authorized by the registered owners thereof, the production during the journey and the surrender at the end of the journey by the holders thereof of tickets issued to them;

(v) Requiring passengers in such cars or buses, if so requested by the drivers or conductors thereof, to leave the cars or buses on the completion of the journey for which they have paid;

(vi) Requiring the surrender of tickets by the holders thereof on the expiration of the period for which they are issued;

(14) As respects every public stand in any specified area or any public stand:

(i) Regulating the use of the public stand and authorizing the issue of permits in that behalf;

(ii) Prescribing the fees to be charged for such permits, and the manner of disposal of the fees recovered on the issue of such permit;

(iii) Prescribing the manner in which motor vehicles may enter or leave the public stand or be placed therein;

(iv) Regulating and controlling the behavior of the drivers and conductors of motor vehicles using the public stand;

(v) Prohibiting or restricting the cleaning or repair of motor vehicles in the public stand;

(vi) Restricting the admission or entry of persons into the public stand and regulating the behavior of persons who enter therein;

(15) Prescribing the minimum rates of the wages to be paid by the owners of hiring cars, motor buses or trucks to the drivers and conductors employed by them;

(16) Prescribing the particulars which are to be entered by the driver of a bus in the record-sheet required by Section VIII–24, and the manner in which and the intervals at which such particulars are to be entered;

(17) Prescribing the circumstances in which and the conditions subject to which, exemption from the provisions of Section VIII–24 and VIII–25 may be granted by the Commissioner in respect of any bus or hiring car;

(18) Providing that any specified provision of this Part shall not apply in the case of any truck which is for the time being used for the purposes of Union Government services.

(*b*) No regulation applicable in any area within the administrative limits of any local authority shall be made for or in respect of any matter for which that local authority may make bylaws or regulations under any other written law, except with the prior approval of the Ministry of Transport and Communications.

PART IX

EXAMINATION, INSPECTION AND TESTING OF MOTOR VEHICLES

IX–1 (*a*) For the purpose of ascertaining the mechanical condition of any motor vehicle or the condition of the tires fitted thereon, any examiner or authorized officer:

(1) May stop a motor vehicle on a highway if he has reasonable grounds for believing that the vehicle or any tire fitted thereon is not in a fit condition; and may by written order direct the driver of the vehicle to produce the vehicle for examination at any suitable place reasonably convenient to the driver and specified in the order; and

(2) May in any case where the motor vehicle has been or is suspected to have been involved in an accident, enter, test and inspect the vehicle, wherever it may be, and may for that purpose require it to be stopped or enter any premises on which the vehicle is for the time being kept or suspected to be kept;

IX–2 Power of Registrar to require inspection and examination of all vehicles, provide for hiring of garages, etc., to act as inspecting agents.

PART X

ADMINISTRATION AND PROCEDURE

Section

X-1 (*a*) There may be appointed persons to be or to act as:

(1) Commissioner of Motor Traffic, and referred to herein as Commissioner;

(2) Such deputy and assistant commissioners as may from time to time be required for the purposes of this Code;

(3) Registrar of motor vehicles, and referred to herein as Registrar;

(4) Such divisional road transport officers, certifying officers and examiners of motor vehicles as may from time to time be required for the purposes of this Code.

X-2 Subject to the provisions of this Code, the Commissioners shall be charged with the following functions and duties:

(1) The control, organization and coordination of passenger and goods transport by road;

(2) The making of recommendations to the Minister of Transport and Communications and the Transport Commissioner, with regard to the coordination of road transport with rail transport and with all other commercial transport; and

(3) The other powers, functions and duties conferred or imposed on the Commissioner by or under this Code.

PART XI

OFFENSES, PENALTIES AND PROCEEDINGS IN COURT

XI-1 (*a*) Any person:

(1) Who contravenes any provision of this Code or any regulation, or fails to comply with any order, direction, demand, requirement or notice lawfully issued, made or given under any provision of this Code or any regulation; or

(2) Who being the holder of any permit or licence granted or issued under this Code, fails to comply with any condition attached to that permit or license, as the case may be,

shall be guilty of an offense under this Code, unless he establish to the satisfaction of the court that such contravention was not due to any act, omission, commission, default or neglect on his part.

XI-2 Penalties for driving under the influence of alcohol or narcotics; recklessly or dangerously; negligently, without insurance or security; for giving false information; for fraudulent imitation of revenue licenses, registration certificates, identification plates, etc., or insurance or security certificates.

Section

XI-3 Penalties for contravention of the speed, size, load and weight, and wheel and tire limitations of Part VIII, Use of Motor Vehicles on Highways.

XI-4 Penalties for contravention of Part IV, Passenger Vehicle Permits and Part V, Truck Permits.

XI-5 General legal requirements and general penalty limits.

PART XII

SUPPLEMENTARY

XII-1 Definition of fees in Code, and provisions that they be collected by means of revenue stamps, cancelled by or by order of the Commissioner. Fees collected shall be credited to the General Fund.

XII-2 If by reason of an offense under this Code any injury is caused to any highway, or bridge, or to any lamp-post, stand-pipe, telegraph or telephone post or wire, or a gate at a railway crossing, or to any other fixture or equipment of any description whatsoever, affixed or erected on or about a highway and in charge of any department of Government or of any local authority, the department or authority may cause such injury to be repaired, and may either before or after the repairs are effected, recover the estimated or actual cost thereof from the owner of the motor vehicle which caused the injury.

XII-3 Power of Commissioner to decide classifications of motor vehicles, admissibility of evidence from examiner, certifying officer, road transport officer or other prescribed person.

XII-4 Powers of Minister to make regulations which shall not become effective until approved by the Parliament of the Union.

PART XIII

DEFINITIONS

XIII-1 In this Code, unless the context requires otherwise, the following definitions and interpretations shall apply:

Articulated vehicle: define trailer vehicle.

At night: from a quarter hour after sunset.

Commissioner: Commissioner of Motor Traffic.

Highway: includes every place over which the public has right of way, or to which the public or any part of the public is granted access, and every place where the motor traffic therein is regulated by a police officer.

Local Authority: any municipal council, town council or village council.

Truck and Lorry: as generally used, and for the purposes of this Code, the words truck and lorry shall be synonymous.

Transport Commission: the regulating, co-ordinating and governing body for all forms of transport in Burma.

Urban Area: any area within the administrative limits of any local authority; or any other area declared by regulation to be an urban area for the purposes of this code.

O. COMMERCIAL TRANSPORT

Prior to World War II, commercial transport, both of passenger and goods on the highways of Burma, was of relatively small importance. Since the war, and particularly since the commencement of insurgency, highway transport has developed rapidly, notwithstanding the poor condition of road surface and structures over which the transport vehicles must travel. That commercial transport has been able to cope with bad roads and insurgency and still increase business is a demonstration of the flexibility of this mode of transportation.

The advantage of highway transport is that it can operate in areas and provide services that cannot be maintained by the railways, either because there are no railway facilities at the origin or the destination of the goods, or because the railways cannot operate with sufficient flexibility to meet changing conditions. Highway transport is certain to grow with the development of the country, and should be encouraged to do so, but it should be regulated to achieve the best over-all development of the Union transportation system.

The Civil Supplies Labor and Transport Union operates a trucking system in the Rangoon area. It is a cooperative enterprise supported by the Union under a management committee of 14 members. This organization owned 35 trucks in 1951, but that number has decreased to 16 in 1953 through obsolescence and inability to provide spare parts. Hauling service is also furnished to Pegu and Tharrawaddy.

The rates charged vary. Within Rangoon corporate limits both trip rates and commodity ton rates are used, while for hauling outside of Rangoon either ton-mile rates or a daily rental rate is charged. Typical rates are as follows:

Rangoon, Army hauling,	3-ton truck	K10	per trip
	,, ,,	K5.75	per ton
Rangoon, civil supplies	Condensed milk	K7.25	per ton
	Sugar	K7.00	,, ,,
	Cotton yarn	K10.00	,, ,,
	Hardware	K10.25	,, ,,
Mingaladon, Army hauling,	3-ton truck	K23.00	per trip
	5 ,, ,,	K24.00	,, ,,
Outside Rangoon,	per ton-mile	K0.45	,, ,,
	3-ton truck	K45.00	per day
	5 ,, ,,	K46.00	,, ,,

The only rate above that can be compared with Burma Railways charges is that of K0.45 per ton-mile for hauling outside of Rangoon. This is approximately three times the Railway's rate for bulk commodities on long hauls.

There are a number of private trucking operators who each own one or more trucks and run unscheduled trucking services to various towns and cities of Burma. Typical rates for these services as compared to the Rangoon–Mandalay rate of Burma Railways are as follows:

RATES

Origin and Destination	*Truck K per ton-mile*	*Burma Railways K per ton-mile*
Rangoon–Mandalay	0·217	0·1432 average
Rangoon–Prome	0·283	
Rangoon–Pegu	0·565	

The number of vehicles engaged in this service is understood to be:

1,227 operating between Rangoon and North Burma.
8,850 operating on various routes in Burma.

The cooperatives and private trucking firms have the advantage over Railways in their facilities for soliciting traffic and their ability to negotiate rates. They are also able to operate more freely through insurgent-held areas than can Railways. Highway transport operators are at a disadvantage in that their rates on long hauls are about 50% higher than the railway rate and probably cannot be reduced while operating under existing road conditions and with their present fleet of small-capacity trucks. To meet the competition of private trucking, Burma Railways should give consideration to establishing feeder lines by using highway transport to bring traffic to their stations from towns to which they have no lines.

P. TRANSPORT COMMISSION

The need for a transport commission to regulate rates and services on all common carriers of passengers and goods has been outlined in Chapter X. It is proposed that highway transport be subject to the regulatory activities of this body. The control of highway transport can be maintained through the device of licensing the transport facilities over specific routes, or for unscheduled service. Licensing common carriers has been recommended as a function of the transport commission.

Q. RECOMMENDED CHANGES IN GEOMETRICS AND LOCATION

As indicated in Section C of the Report where the general features of the present route locations, alignment and geometrics are outlined, certain faults in these features were observed during the inspections of the Union and district routes. Details of the faults and recommended corrective measures are listed below. The data and recommendations are shown by routes, and on each the locations are generally outward from Rangoon. Local by-pass projects and relocations are distinguished in the list just below by italics. The major relocations are described in subsection 2, below.

These modifications are chosen to reflect current modern highway practice, and to conform reasonably to the new standards of design proposed elsewhere in this Report. The present conditions of structures and recommended repair, reconstruction and replacement are also shown elsewhere in this Report.

1. RECOMMENDED CHANGES ON UNION ROUTES

Route I (Rangoon–Mandalay, east)

Mile 50–Mile 100—From south of Pegu to approximately Pyuntaza there is occasional flooding during June–July at a number of locations. Where needed, the grades should be raised.

Daiku—A slight relocation in the main route, west of the village, is proposed.

Pyuntaza—Slight changes, at a small cost, should be made in the route alignment through the south part of town. Also, the sharp bends 3·2 miles north of town should be eliminated.

Nyaunglebin—The highway should be relocated to by-pass the town, although one crossing of the Railway is still needed. The new by-pass would be 0·9 mi. in length, compared to 1·45 for the present route. The sharp bends 1·5 mi. north of town should be eliminated.

Peinzalok—Improve the road to west of the town, by easing the curves, making other minor improvements.

Kyauktaga to north—Relocate 2·6 mi. of highway to west of railway to eliminate two grade crossings and two very abrupt bends in the alignment. The relocation will include the replacement of the existing structure over Tonkan Chaung, south of Penwegon, and a modification in the alignment of the Kungyangwa road (to the east) to provide for a combined use of the new structure.

Penwegon—The by-pass will eliminate the grade crossings in the village and three very sharp curves in the existing road.

Mile 173·5—Flatten the curve at the Railway crossing here, 3·5 mi. south of Toungoo, and another at the crossing of Kaban Chaung, 2·3 mi. south of the city.

Toungoo—Modify the alignment at the north edge of the city, to eliminate two very sharp bends.

Myohla—At the crossing of the railway, in town, fix the sharp curve and increase the radius on several bad curves one mi. to the north, and another at the south edge of Yeni.

Thwatti—A minor relocation of the route in the town should be undertaken to do away with two sharp curves; and a realignment is needed at the crossing of the railway 6·5 mi. to north to eliminate a sharp left curve.

Lewe—Eliminate the sharp bend one mi. north of the village.

Mile 271—Raise the grade near Mon Chaung, to eliminate flooding.

Mile 272—Just north of the crossing of the Sinthe Chaung, 5·5 mi. south of Tatkon, there is a sharp turn which should be taken out.

Seinzabin—Eliminate the sharp double curve here, and realign the highway to eliminate the bend 0·4 mi. south of the crossing of Nawin Chaung.

Mile 312·5.—The double crossing of the railway just north of Zidaw and in Pyawbwe could be eliminated by a 2·5-mi. relocation of Route I to the west of the railway.

Mile 320–Mile 328—Flooding often occurs at several points of this section, and the grades should be raised accordingly.

Kandaung—Eliminate the sharp curve 1·1 mi. south of the village, and the reverse curve 1·7 mi. to the north.

Meiktila—The proposed by-pass for Route I in this city could consist of improving an existing road from Route IV northward 0·5 mi. to Khanda, crossing the railway, and the construction of one mi. of the new road, location to pass east of Kyingon, and thence joining the location of existing Route I just to the north.

Ngathet—The sharp curve 0·7 mi. north of the village should have its radius increased.

Wundwin—The alignment of Route I through the village should be bettered by a slight relocation.

North of the Shawbin Chaung at the north edge of Wundwin, there are a total of 31 bridges in a 6½-mi. length of the national highway. In ordinary practice, this would be very unusual. It is believed that some of these are drainage structures no longer effective and could thus be abandoned and no longer maintained.

Ywashe—Two sharp curves should be improved, by relocation to furnish increased radius, and an improvement can also be made at Shwedaung by a slight relocation.

Between Yetwa and Kyaukse, a distance of 7·5 mi., there are 16 bridges on Route I.

Ywatha—Improve the alignment by eliminating the sharp bend in the road in the village, close to the crossing of the Zawgyi.

Nyaungbinggyi—A relocation, to reduce the sharp curve in the roadway, is proposed.

Sizon—A 2·5-mi. relocation is recommended to eliminate the railroad crossing here and a second one near the Paleik railroad station.

Tagundaing—A very sharp reverse curve 0·8 mi. north of the village should be eliminated by relocation.

Route II (Rangoon–Mandalay, west)

Mile 38, from Rangoon—Two sharp bends at the approaches to the bridge at Myaungtanga should be eliminated.

Mile 46—Two sharp bends at 0·4 mi. south of Taikkyi and another 0·3 mi. north should be replaced with curves of proper radii.

Okkan—Realign highway south of village to eliminate sharp bend there, and another at south edge of village.

Tharrawaddy—Route should be relocated at south edge of city, to remove sharp bend in alignment.

Letpadan—Eliminate sharp bend to right.

Gyobingauk—At railway crossing 4·8 mi. south of village, the short-radius curve on the highway should be eliminated.

Pyalo—Several sharp curves, in and close to the village, should be replaced with those of longer radii.

Allanmyo—Relocate the highway to eliminate the bad double curve at the north end of town, and several curves just to north.

Leindaw—Several sharp curves and bends occur near the village, and others two mi. south of Egayit. These should be eliminated, and the curves north of Pakkon should also be improved.

Nyaungbintha—At the crossing of the Linban Chaung, a slight alignment change is needed.

Tanbinde—Here, a double curve enclosing the railway crossing should be relocated to improve both alignment and sight distance.

Kyaukpadaung—North of the town, the crossing of Taungzin Chaung will require a structure nearly 400 ft. in length.

Popa—The switchback in the present alignment, 1·5 mi. to the south and the bad curves the same distance to the north should be removed.

Eywa—Extensive alignment changes will be necessary in the village, 2·5 mi. to the south. It is also proposed that a relocation be planned to eliminate three sharp curves about 1·2 mi. south of Taungtha.

Taungtha—The routing and alignment through town should be improved.

Route III (Mandalay–Lashio)

Mile 51–Mile 52·5—The severe curvature condition in this 1·5 mi. of highway can be corrected by a short relocation, near Yethalaukkan, and between Miles 53·5 and 54·5 a sharp curve should be eased, and the grade changed.

Mile 70.—There needs to be a slight relocation to overcome severe curvatures.

Hsipaw, Mile 125. There are several very sharp turns on Route III in the village, and these should be eliminated.

Route IV (Meiktila–Indo-China, via Takaw)

Meiktila—In the east side of the city, the alignment of Route IV should be improved to eliminate sharp bends at the railway crossing in Tamongan and just west of the Kyeikpale station; or better still, keep the 3·5 mi. of route south of the railway and avoid both crossings and the several villages now traversed.

Mile 232–Mile 252—This stretch of rough and mountainous graveled highway extends eastward from nine mi. west of Kunghing, where the route crosses the Nam-Pang River. It should be relocated to reduce the grades and better the alignment at the time the route is improved to increase freight traffic and commercial trade with Indo-China.

Route V (Toungoo–Ho-Pong)

Mile 0–Mile 30—A number of minor relocations are needed, mainly to improve curvature on the way to Mawchi.

East of Toungoo, the route crosses the Sittang River. There are very sharp curves 0·3 and 2·5 mi. east of the crossing, and these should be eased.

Loikaw–Pyinmana—A connection from Route V westward to Route I at or near Pyinmana is proposed in the current highway program, and preliminary work has already been done on some portions of the project. A route proceeding eastward from Yezin (on Route I) to Pinkhwun, and there connecting to the district road extending to Pekon, from which it would proceed southward to Meng-Pai, and thence to Route V, would probably offer the best engineering location, at least cost, for this connection. It is recommended that the validity of such route, or feasible alternative, be established at once by aerial mapping and that the location and detail design be established on this basis.

Route VI (Yunnan–Assam, via Myitkyina)

Almost all of this route is that which was built during World War II, to furnish transport and supply aid to the military operations in Burma and across into China. Most streams are not bridged, the crossings being by ford only. The route is almost entirely of general mountain construction, and in any reconstructions undertaken the earthwork quantities are likely to be material.

A systematic program of planning and construction should be undertaken for the improvement of this road as a potential trade artery with Burma's neighbors. The major fords will have to be replaced with permanent crossings, the sharp curves and abrupt bends in various portions of the route should be eliminated and the grades should be reduced to favor truck operation.

Branching northward from Route VI at Myitkyina, there is a dry-weather jeep road extending to Sumprabum and Putao. The route follows, generally, the west bank of the Irrawaddy. In view of the possible development in this portion of northern Burma, surveys and planning should be undertaken, on a limited basis, for the improvement of this road. The general location is good, but the detailed alignment and grades will have to be much improved to raise the road to even an all-weather secondary facility.

Route VII (Mandalay–Tamu, via Shwebo)

Mile 8–Mile 9, from Mandalay—The grade on this portion of Route VII should be raised sufficiently to avoid the occasional flooding from the Irrawaddy.

Mile 96–Mile 198—Between Ye-U and Kalewa, there are many chaungs, and their crossings are often delayed by flood waters.

Mile 175–Mile 183—In this stretch between Pyinmana and Shwegyi there are three sections of hill construction which are subject to landslides. The condition should be corrected by proper treatment of the back slopes and deep cuts.

Route VIII (Payagyi–Mergui)

Kyaikhla—At the railway crossing in the village, a slight improvement in the alignment is needed, to take out the sharp bend and the two short radius curves now existing.

Mile 10·5, from Payagyi—At the Waw, improve the approach grades and alignment at the crossing of the Pegu Sittang Canal. This work should be done when the existing one-lane Bailey bridge is replaced.

Mile 238·5–Mile 240·5—Some alignment changes are needed over this portion of the route, starting 13·5 mi. south of Ye.

Mile 338—A sharp bend in the road occurs here and should be eliminated.

Mile 355·3—A sharp bend occurs here, another occurs at Mile 360, and minor alignment changes are needed in the next 1·5 mi.

Mile 398—Starting at this point on the road, which is 77 mi. south of Tavoy, numerous alignment changes should be made in next six mi. of route, to improve curvature.

Mile 409—There are two sharp bends here which should be eliminated and numerous short relocations are needed in the six-mi. stretch starting at Mile 412·7.

Mile 421–Mile 431—In this section of Route VIII, starting 37 mi. south of Tavoy there are numerous bends and sharp curves which should be eliminated. It is estimated that a total of 2·5 mi. of relocation will be needed.

Mile 444—Tamok River. The road south of here, for a total distance of 2·5 mi., should be relocated to improve the curvature and eliminate the many angular turns on the route.

2. MAJOR RELOCATIONS ON NATIONAL ROUTES

In studying the methods that might be used to better the traffic and highway conditions on the national routes, investigations were made of several locations where the general alignment and profile were restrictive, especially to heavier vehicles. These portions should be redesigned and relocated. In other locations major by-passes should be constructed. These major relocations and by-passes are described and explained as follows:

Route II (Rangoon–Mandalay, west)

(a) Taungdwingyi–Kyaukpadaung. In order to permit through traffic to avoid delays in passing through Magwe and Yenangyaung it is proposed that a major by-pass be constructed. This relocation, using the road-bed of the westerly portion of the abandoned rail line between Kyaukpadaung and Pyinmana, via Natmauk, will reduce the total length of Route II by 32 mi. The proposal is discussed later, under major relocations, and is shown on Plate 13.

With the present alignment at Magwe, there are several sharp bends, especially at the south end of the city. These could be eliminated if a by-pass of limited length were constructed instead of the major project just mentioned. The limited by-pass would consist of the improvement of 1·7 mi. of the district road running generally north and south, and located east of the city. With this short by-pass, the existing highway should also be improved by minor alignment changes for the ten-mi. stretch to the north of Kadaung Chaung. A major structure, 1,300 ft. in length, would be required at this chaung.

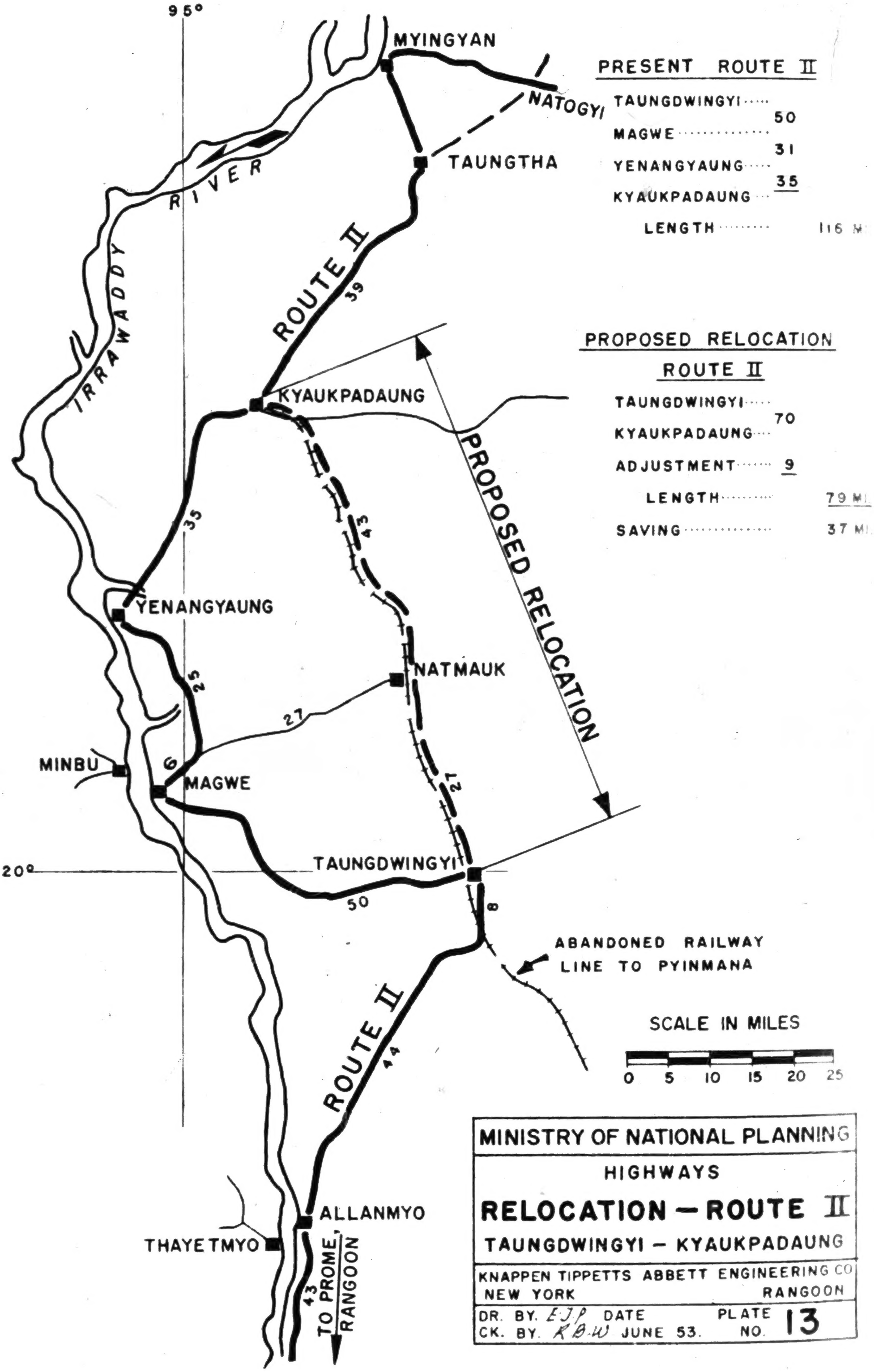
Instead of the major by-pass recommended to take through traffic out of both Magwe and Yenangyaung, it would alternatively be possible to construct a local by-pass for Yenangyaung, located about two mi. east of town. It would depart from the existing Route II about two mi. east of Nyaunghla village and proceed generally north for a distance of approximately four mi., to rejoin the existing route at Twingon village. There would be 1·3 mi. of new construction, the remaining 2·7 mi. being improvement of the line and grades of existing district and dry-weather roads.

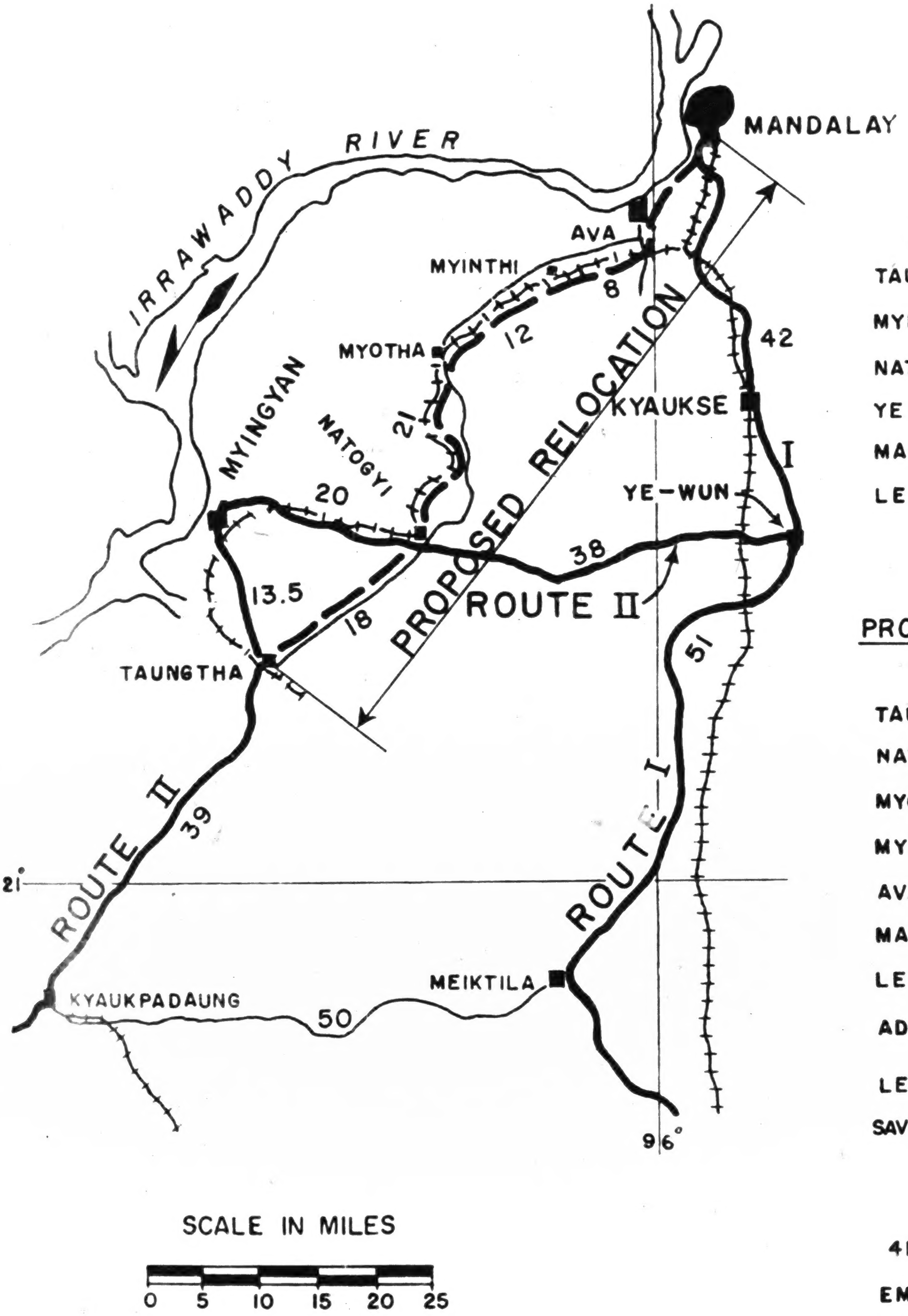
With this improvement of the route, the 750-ft. ford at the Pin River crossing near Obo would have to be replaced with a permanent structure, and the sharp curves one mi. south of Mindaung, and at Gwekyo should be eliminated. It is recommended that the major relocation shown on Plate 13 be adopted.

(b) Taungtha–Mandalay. Based upon similar studies in the Taungtha–Myingyan–Mandalay section of Route II, it is recommended that a second major relocation be planned and constructed on Route II to direct the through traffic from Taungtha into Mandalay without becoming involved in the local traffic in and around Myingyan. The proposal, which includes the use of 41 mi. of the abandoned Railways road bed north of Natogyi and into Ava, will save more than 26 mi. in travel to Mandalay, as compared to the present routing of Highway II, through Ye-Wun, and thence north on Route I. The relocation is shown on Plate 14.

Route III (Mandalay–Lashio)

(a) Going eastward from Mandalay on Route III, there begins at Mile 167 a very tortuous and steeply profiled road. The section climbs from an elevation of approximately 400 ft. to one of 2,450 ft. in a distance of a little more than nine mi. The grades are steep, the maximum rates being up to 20%. There are 22 switch-


95°
20°
MYINGYAN
NATOGYI
TAUNGTHA
IRRAWADDY RIVER
ROUTE II
39
KYAUKPADAUNG
35
YENANGYAUNG
25
6
MINBU
MAGWE
27
NATMAUK
43
27
PROPOSED RELOCATION
TAUNGDWINGYI
50
8
ABANDONED RAILWAY LINE TO PYINMANA
ROUTE II
44
ALLANMYO
THAYETMYO
43
TO PROME, RANGOON
PRESENT ROUTE II
TAUNGDWINGYI
50
MAGWE
31
YENANGYAUNG
35
KYAUKPADAUNG
LENGTH 116 M
PROPOSED RELOCATION ROUTE II
TAUNGDWINGYI
70
KYAUKPADAUNG
ADJUSTMENT 9
LENGTH 79 MI
SAVING 37 MI
SCALE IN MILES
0 5 10 15 20 25
MINISTRY OF NATIONAL PLANNING
HIGHWAYS
RELOCATION — ROUTE II
TAUNGDWINGYI — KYAUKPADAUNG
KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON
DR. BY. E.J.P. DATE
CK. BY. R.B.W. JUNE 53.
PLATE NO. 13


MANDALAY
IRRAWADDY RIVER
AVA
MYINTHI
8
MYOTHA
12
42
PROPOSED RELOCATION
MYINGYAN
NATOGYI
21
KYAUKSE
I
YE-WUN
20
38
13.5
ROUTE II
18
TAUNGTHA
51
ROUTE II
39
ROUTE I
21°
KYAUKPADAUNG
50
MEIKTILA
96°
SCALE IN MILES
0
5
10
15
20
25

PRESENT ROUTE II

TAUNGTHA		
MYINGYAN	13.5	
NATOGYI	20	
YE-WUN	38	
MANDALAY	42	
LENGTH		113.5

PROPOSED RELOCATION
ROUTE II

TAUNGTHA		
NATOGYI	18	
MYOTHA	21	
MYINTHI	12	
AVA	8	
MANDALAY	12	
LENGTH	71	
ADJUSTMENT	8	
LENGTH		79
SAVING IN LENGTH		34.5

41 MILES ON RAILWAY EMBANKMENT FROM NATOGYI TO AVA

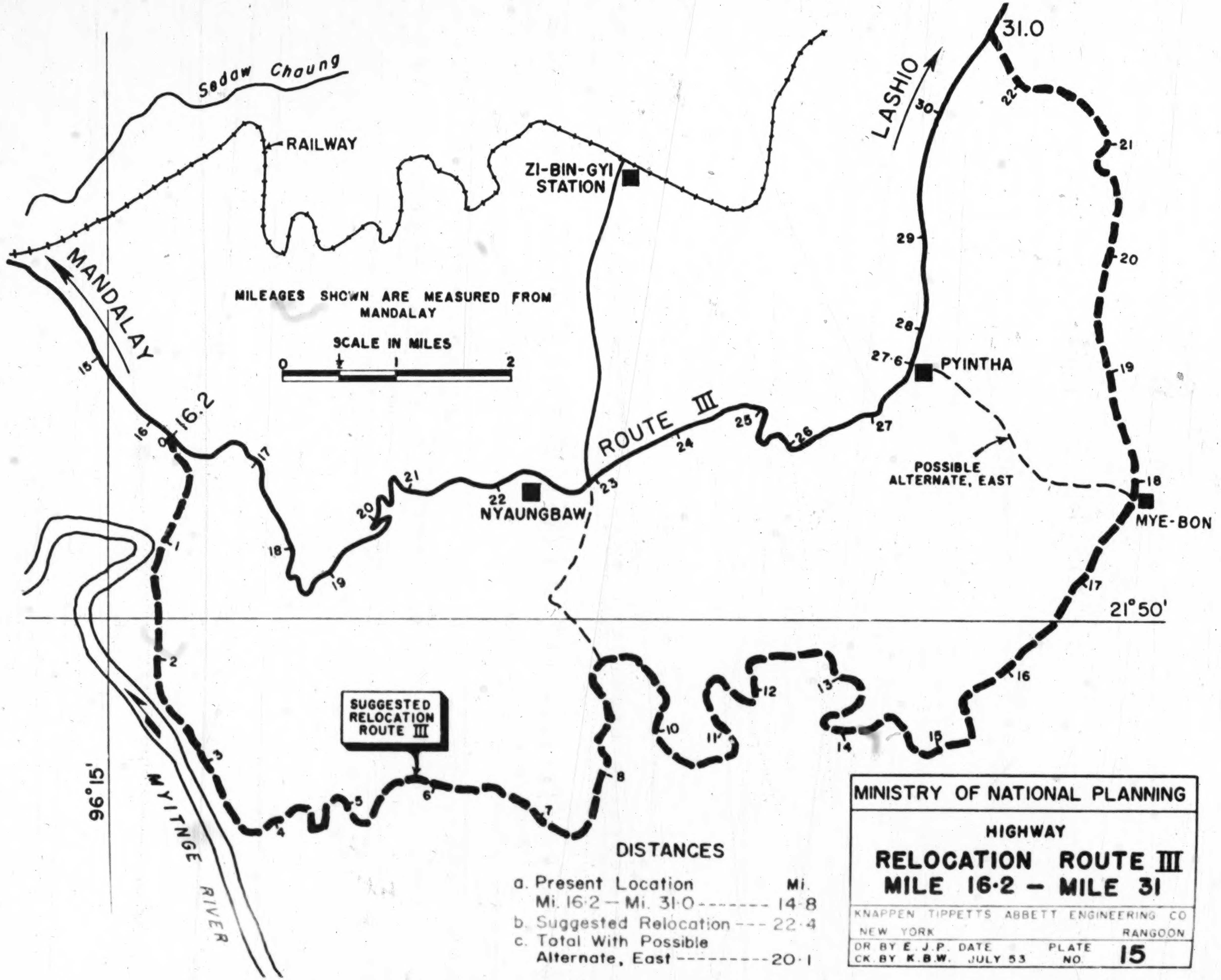
MINISTRY OF NATIONAL PLANNING

HIGHWAYS

RELOCATION, ROUTE II
TAUNGTHA – MANDALAY

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. E.J.P. DATE
CK. BY. K.B.W. MAY 53
PLATE NO. 14


MINISTRY OF NATIONAL PLANNING
HIGHWAY
RELOCATION ROUTE III
MILE 16·2 – MILE 31
KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK
RANGOON
DR. BY E. J. P.
CK. BY K. B. W.
DATE JULY 53
PLATE NO. 15
DISTANCES
Mi.
a. Present Location Mi. 16·2 — Mi. 31·0 14·8
b. Suggested Relocation 22·4
c. Total With Possible Alternate, East 20·1
MILEAGES SHOWN ARE MEASURED FROM MANDALAY
SCALE IN MILES
0
½
1
2
Sedaw Chaung
RAILWAY
ZI-BIN-GYI STATION
MANDALAY
LASHIO
31.0
16.2
ROUTE III
NYAUNGBAW
PYINTHA
27·6
POSSIBLE ALTERNATE, EAST
MYE-BON
SUGGESTED RELOCATION ROUTE III
MYITNGE RIVER
96°15'
21°50'
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
0
1
2
3
4
5
6
7
8
10
11
12
13
14
15
16
17
18
19
20
21
22

backs, and with such curvatures that the process is practically continuous. As to combined profile and alignment effect, Miles 18–21 and Miles 24·5–26 are especially severe. This portion of the road as now located will always prove to be a severe, dangerous and even impossible barrier to the flow of heavy trucks under expanded traffic. The alignment should be improved, and the ruling grade should be reduced to something in the magnitude of 7%.

The major relocation shown on Plate 15 was therefore investigated. The new portion of the route extends from Mile 16·2 to Mile 31 of the existing route, a present distance of 14·8 mi. The design and adoption of this location are recommended.

(b) **Mile 80–Mile 92.** Over this 12-mi. distance of Route III, the alignment and grade conditions are very unsatisfactory at present. The road descends from an elevation of 2,800 ft. into the deep gorge of the Goteik River, and at once rises again to an elevation of about 2,500 ft. The route includes 35–36 switchback curves, which are dangerous even under good conditions. At these sharp curves, the paving has not been widened, and remains only 10–12 ft. in width. The maximum grade must be reduced, too, from the present 14–15% to a maximum of 7% to permit the use of the road by heavily loaded transport trucks.

Mile 81–Mile 83 and Mile 86–Mile 87·5 (where the present road passes close to Pangpao Station on the railway) portions are especially tortuous and unsafe.

A very rough plan for the relocation of this section has been laid down upon existing topography maps, for estimating purposes, but it is recommended that aerial surveys, at large scale, be made of the area in order that a proper and detailed study may develop the best relocation possible through this rugged terrain.

3. LOCAL IMPROVEMENT PROGRAM

As outlined in some detail in Section D, Traffic, a program of basic improvements in the Union and district highway systems within local communities should be undertaken. The planning and execution of such program should be a joint project between the planning group of the newly constituted Department of Roads and the local and district highway authorities. The development of detailed standards for the program, following the general design standards proposed in Section F of the Report, should be the basic responsibility of the planning group. The carrying out of the program will require much cooperation between the Road Department and the local authorities, to whom the concept and procedures will be new. Pilot projects should be undertaken in several of the districts of the Union early in the program to develop the techniques and procedures.

With the mechanization of the major construction and maintenance operations of the Department of Roads, as recommended elsewhere in the Report, the labor force now engaged upon hand operations can be used upon certain operations in connection with the local improvements. Additional personnel will also be required, if this work is to be carried out at the rate that is called for by the over-all program. The introduction of new methods and concepts will require that a training program be carried out, and the guidance for this will also have to come from the experienced staff of the Department of Roads.

In order to determine the scope of local improvements, studies have been made as to the extent of such work required in and around the various cities, towns and villages in all parts of the Union. The results of these preliminary studies, expressed as miles of improvements upon national routes and local streets are shown in Table XVI–22 (*see next page*) and summarized in Table XVI–23 (*see p. 456*). Studies have also been made for local improvements in district and secondary roads. These are listed in Table XVI–24 and Table XVI–25 (*p. 456*) and summarized in Table XVI–26 (*see p. 461*).

It will be noted that no recommendations have been made for a program of local improvements in Rangoon. This is a major project, and should be worked out cooperatively by the Department of Roads and the Corporation. As an initial project, however, it is recommended that the intersection of Sule Pagoda Road and Bogyoke Street be reconstructed to ease the flow of traffic and to reduce the number of traffic police necessary to control the intersection. The existing traffic circle should be eliminated and turning movements should take place in the quadrants of the intersection. Restricted crossing areas should be provided for the protection of pedestrians. Suitable traffic-control signals and directional signs will also be necessary. The existing conditions at this location are described in detail in Section D, paragraph 2–b of this chapter.

Maps for those projects which are recommended for "pilot" purposes are given on Plates 16 (Local Improvements, Pyinmana), 17 (Local Improvements, Prome), 18 (Local Improvements, Shwebo) and 19 (Local Improvements, Henzada). Further studies and similar maps should be made for each of the communities listed in the program, and this work should proceed as rapidly as funds and the availability of trained personnel permit.

It will be noted that in Table XVI–27 (*see p. 462*), in which a budget is proposed for the first-year highway program, funds are included for local improvements in five cities on national routes (totaling 23·5 miles and with an estimated cost of 28,50,000 kyats) and in eight communities in the district road system (totaling 28·5 miles and with an estimated cost of 24,00,000 kyats).

TABLE XVI – 22

LOCAL IMPROVEMENT PROGRAM COMMUNITIES ON UNION ROUTES

City or Town	1953 Population	Mileage to be Improved: On National Roads: In City	Mileage to be Improved: On National Roads: Outside	Mileage to be Improved: On Streets
ROUTE I				
Mandalay*	182,367	4·5	2·0	9·0
Pegu*	45,941	2·5	1·4	1·5
Toungoo*	31,180	2·0	1·1	2·1
Pyinmana	22,025	2·8	1·8	—
Meiktila*	19,474	2·0	1·1	0·5
Yamethin*	11,167	1·3	0·8	—
Pyu*	10,444	1·9	0·6	—
Kyaukse*†	8,668	1·1	0·7	—
Subtotal, cities and towns over 10,000		18·1	9·5	13·1
Daik-U	97‡	1·4		0·6
Hlegu	67	1·2		0·3
Kanyutkwin	55	2·0		0·6
Kyauktaga	60	0·6		0·2
Kywebwe	31	1·0		0·5
Lewe	58	0·6		0·2
Myohla	33	0·5		0·2
Myitnge	39	0·5		0·2
Nyaungchidauk	19	0·4		—
Nyaunglebin	19	0·7		0·3
Nyaungbintha	17	0·5		—
Oktwin	37	0·5		—
Payagyi	37	0·4		—
Peinzalok	37	0·8		0·2
Penwegon	55	0·6		—
Pyinbongyi	29	0·5		0·2
Pyuntaza	95	1·1		0·7
Pyawbwe	95	0·9		0·4
Shwemyo	10	0·8		0·2
Swa	15	0·7		—
Tatkon	27	0·6		0·2
Wundwin	23	0·4		0·2
Yedashe	45	1·0		0·6
Zeyawadi	70	0·6		0·2
Subtotal, cities and towns under 10,000		18·3		6·0
Total, Route I		36·4	9·5	19·1

City or Town	1953 Population	Mileage to be Improved: On National Roads: In City	Mileage to be Improved: On National Roads: Outside	Mileage to be Improved: On Streets
ROUTE II				
Prome*	36,762	2·9	1·6	2·6
Myingyan*	36,439	2·7	1·5	2·1
Insein*	28,672	1·1	—	0·8
Yenangyaung	24,430	4·2	—	2·0
Paungde	17,188	0·8	0·2	1·7
Taungdwingyi	16,248	0·9	—	0·7
Allanmyo	15,702	1·2	0·2	0·3
Letpadan	15,635	1·7	—	0·8
Thonze	14,149	0·6	—	0·4
Magwe*	12,229	2·9	0·3	1·8
Tharrawaddy*†	7,637	1·0	—	1·5
Subtotal, cities, and towns over 10,000		20·0	3·8	14·7
Gyobingauk	98‡	0·8	—	1·0
Hmawbi	51	1·5	—	—
Kyaukpadaung	55	1·4	—	0·6
Natoggyi	41	0·6		0·2
Nattalin	87	1·0		0·5
Shwedaung	90	1·0		2·0
Taikkyi	87	1·1		0·3
Taungtha	54	1·0		0·5
Zigon	89	0·8		0·2
Subtotal, cities and towns under 10,000		9·9	—	5·3
Total, Route II		29·2	3·8	20·0
ROUTE III				
Mandalay*	182,367	3·7	—	with I
Maymyo	21,483	1·8	0·4	0·6
Subtotal, cities and towns over 10,000		5·5	0·4	0·6
Hsipaw	56‡§	1·8	0·6	0·8
Lashio	64§	0·8	0·5	0·3
Hsenwi	41§	1·0	0·2	0·3
Kutkai	23§	0·5	—	0·2
Subtotal, cities and towns under 10,000		4·1	1·3	1·6
Total, Route III		9·6	1·7	2·2

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* District capital.
† Included in list, as district capital.
‡ Population, if under 10,000 to nearest one hundred.
§ 1953 estimated from earlier years.

TABLE XVI – 22—(*continued*)

LOCAL IMPROVEMENT PROGRAM COMMUNITIES ON UNION ROUTES

City or Town	*1953 Population*	*Mileage to be Improved*		
		On National Roads		*On Streets*
		In City	*Outside*	
ROUTE IV				
Meiktila*	19,474	0·4	0·2	with I
Taunggyi	14,500§	1·6	0·8	1·1
Subtotal, cities and towns over 10,000		— 2·0	— 1·0	— 1·1
Thazi	75†	1·0	0·4	0·3
Kalaw	47	1·1	0·3	0·6
Ho-Pong	21§	0·6	—	—
Loilem	28§	0·7	—	0·4
Kunhing	31§	0·4	—	0·3
Keng-Tung	70§	1·4	0·6	0·8
Subtotal, cities and towns under 10,000		— 5·2	— 1·3	— 2·4
Total, Route IV		7·2	2·3	3·5
ROUTE V				
Toungoo*	31,180	0·6	—	with I
Subtotal		— 0·6	—	
Bawlake	28†§	0·4		0·2
Loikaw	61§	0·7		0·4
Mawchi	18§	0·2		—
Subtotal, cities and towns under 10,000		— 1·3		— 0·6
Total, Route V		1·9		0·6
ROUTE VI				
Myitkyina*	12,382	2·6	0·4	0·8
Bhamo*	9,821	2·0	—	2·7
Total, Route VI		— 4·6	— 0·4	— 3·5
ROUTE VII				
Shwebo*	17,827	3·0	3·5	2·0
Sagaing*	15,382	3·0	0·2	1·3
Amarapura	11,268	1·4	—	0·6
Subtotal, cities and towns over 10,000		— 7·4	— 3·7	— 3·9
Kin-U	32†	1·0	—	0·7
Kalewa	22	0·7	—	0·9
Mogok	83	0·6	—	0·3
Tamu	17	0·4	—	—
Ye-U	53	0·7	—	0·5
Zigon	23	0·4	—	0·3
Subtotal, cities and towns under 10,000		— 3·8	—	— 2·7
Total, Route VII		11·2	3·7	6·6
ROUTE VIII				
Moulmein*‡	101,720	4·8	1·0	2·5
Tavoy*	40,066	2·5	—	1·7
Thaton*	38,211	2·3	0·6	1·5
Mergui*	33,604	1·8	0·4	0·9
Mudon	20,136	1·3	—	1·0
Kyaikto	13,174	1·5	—	0·6
Ye	12,852	1·3	0·2	0·6
Subtotal, cities and towns over 10,000		— 15·5	— 2·2	— 8·8
Bilin	52†	1·0	—	0·5
Palaw	56	0·8	—	0·4
Paung	69	2·5	—	—
Waw	70	0·9		0·4
Subtotal, cities and towns under 10,000		— 5·2		— 1·3
Total, Route VIII		20·7	2·2	10·1

* District capital.

† Population, if under 10,000, to nearest one hundred.

‡ Including Martaban.

§ 1953 estimated from earlier years.

TABLE XVI – 23

SUMMARY OF LOCAL IMPROVEMENTS ON UNION ROUTES

	Mileage to be Improved			
	On National Routes			
	Inside Cities (miles)	*Outside (miles)*	*On Streets (miles)*	*Total (miles)*
Route I	36·4	9·5	19·1	65·0
Route II	29·2	3·8	20·0	53·0
Route III	9·6	1·7	2·2	13·5
Route IV	7·2	2·3	3·5	13·0
Route V	1·9	—	0·6	2·5
Route VI	4·6	0·4	3·5	8·5
Route VII	11·2	3·7	6·6	21·5
Route VIII	20·7	2·2	10·1	33·0
Total	120·8	23·6	65·6	210·0

TABLE XVI – 24

LOCAL IMPROVEMENT PROGRAM ON DISTRICT AND SECONDARY ROADS CITIES AND TOWNS OVER 10,000†

City or Town	*1953 Population*	*Mileage*	
		On District and Secondary Roads	*On Local Streets*
Bassein*	77,382	2·3	1·5
Henzada*	60,666	2·9	2·3
Akyab*	41,589	1·9	1·3
Pakokku*	29,824	2·0	1·5
Monywa*	26,279	1·3	1·1
Myaungmya*	24,252	2·0	1·5
Chauk	23,916	1·5	1·0
Maubin*	23,442	1·8	0·6
Bogale	23,200	1·8	0·7
Kamayut	22,734	1·2	0·6
Kanbe	21,005	1·0	0·3
Wakema	19,319	1·4	0·7
Pyapon*	19,180	2·0	1·5
Thingangyun	18,129	1·6	0·8
Moulmeingyun	17,055	—	1·4
Kyaiklat	15,790	1·8	0·6
Nyaunglebin	15,557	1·1	0·4
Syriam	15,292	1·9	1·4
Yandoon	15,281	0·9	0·7
Labutta	12,982	1·0	0·6
Thayetmyo*	11,679	1·3	0·4
Myanaung	11,165	1·9	0·4
Kayan	10,906	1·9	0·2
Thongwa	10,784	1·6	0·2
Minbu*	9,093	1·5	1·3
Katha*	7,648	1·8	0·4
Kyaukpyu*	7,241	0·8	0·6
Sandoway*	5,175	0·9	0·7
Mawleik*	2,993	0·9	0·3
Total, cities and towns over 10,000 (29)		44·0	26·0
		70·0	

* District capital. † Capitals under 10,000 also listed.

TABLE XVI – 25

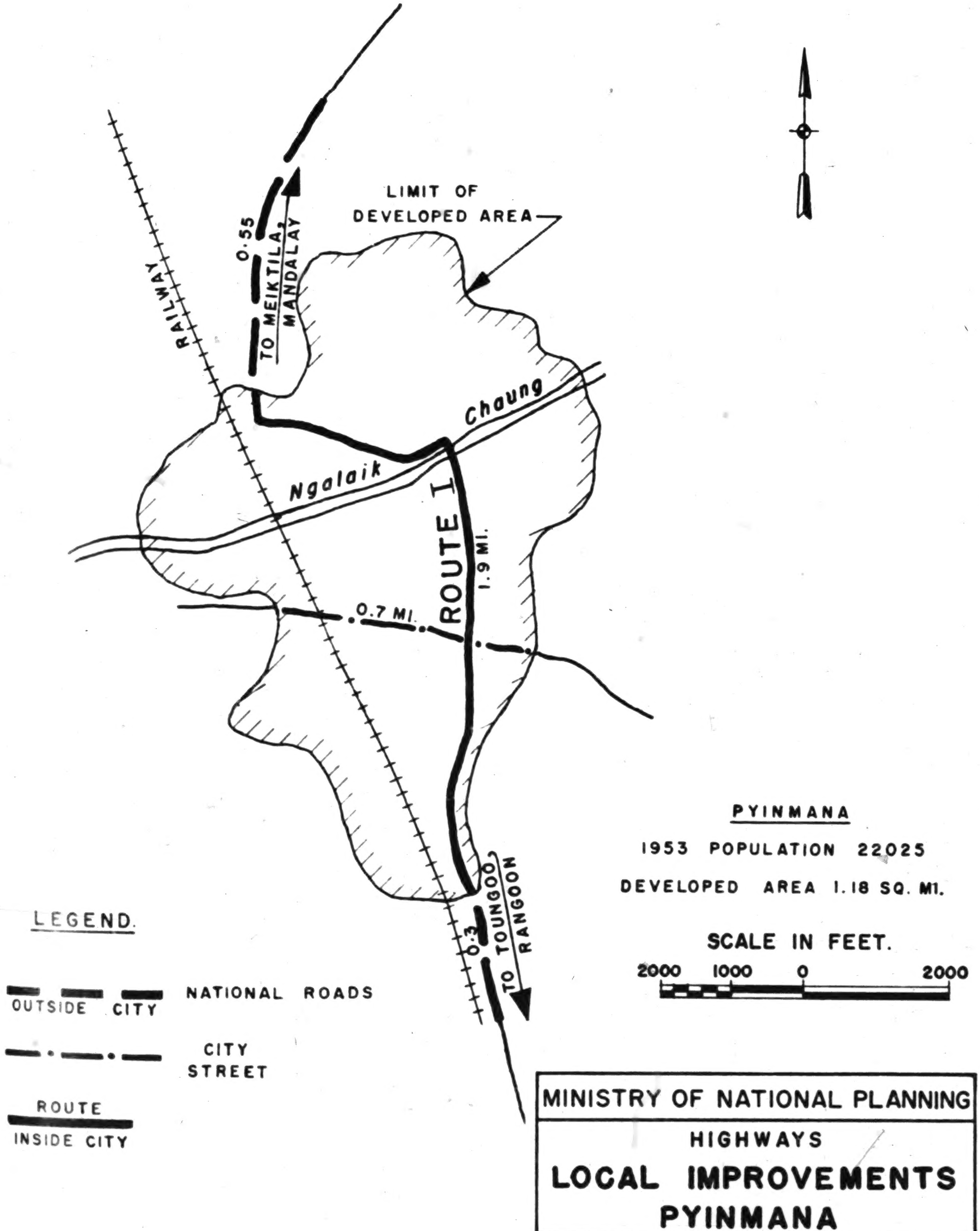
LOCAL IMPROVEMENT PROGRAM ON DISTRICT AND SECONDARY ROADS TOWNS AND VILLAGES UNDER 10,000

Town or Village	*1953 Population to Nearest Hundred*	*Mileage*	
		On District and Secondary Roads	*On Local Streets*
Amherst	60	1·0	0·6
Athok	48	0·9	0·2
Dedaye	78	1·3	0·3
Kanaung	41	1·3	0·3
Kawa	23	1·0	0·2
Kungyangon	49	1·0	
Kyangin	60	0·6	0·3
Kyauktan	38	1·0	0·2
Kyidaunggan	40	0·9	—
Kyonmange	96	—	1·6
Kyonpyaw	53	0·7	0·3
Mahlaing	65	1·8	1·0
Minhla	17	0·6	
Minywa	41	0·7	0·1
Mokpalin	34	1·0	0·4
Monyo	50	0·6	0·2
Myittha	42	0·8	0·6
Neikban	19	1·4	0·6
Ngathainggyaung	81	1·3	0·3
Okpo	44	0·6	0·2
Padaung	34	3·0	
Padigon	17	0·5	
Pagan	28	0·6	0·2
Pantanaw	47	1·0	0·2
Paukkaing	32	0·6	
Paungdale	27	0·5	0·2
Paung-We	65	0·8	0·5
Sagu	51	1·7	0·4
Sinbaungwe	32	0·6	0·2
Tantabin	37	0·7	0·3
Thanatpin	51	0·9	0·2
Twante	69	1·5	0·1
Wettikan	21	0·4	
Total, towns and villages under 10,000 (34)		31·9	9·8
Other towns and villages (91) 1,000–10,000		76·1	27·2
		108·0	37·0

R. GENERAL RECOMMENDATIONS

1. ORGANIZATION

As presently organized the Buildings and Roads Department of the Ministry of Public Works and Rehabilitation has two major functions: (*a*) the construction and maintenance of public buildings and governmental housing not otherwise provided for by the organizations in the several ministries and departments; and (*b*) the maintenance and construction



LIMIT OF DEVELOPED AREA
0.55
TO MEIKTILA, MANDALAY
RAILWAY
Chaung
Ngalaik
ROUTE I
1.9 MI.
0.7 MI.
0.3
TO TOUNGOO RANGOON
LEGEND.
NATIONAL ROADS
OUTSIDE CITY
CITY STREET
ROUTE
INSIDE CITY
SCALE IN FEET.
2000
1000
0
2000

PYINMANA

1953 POPULATION 22025

DEVELOPED AREA 1.18 SQ. MI.

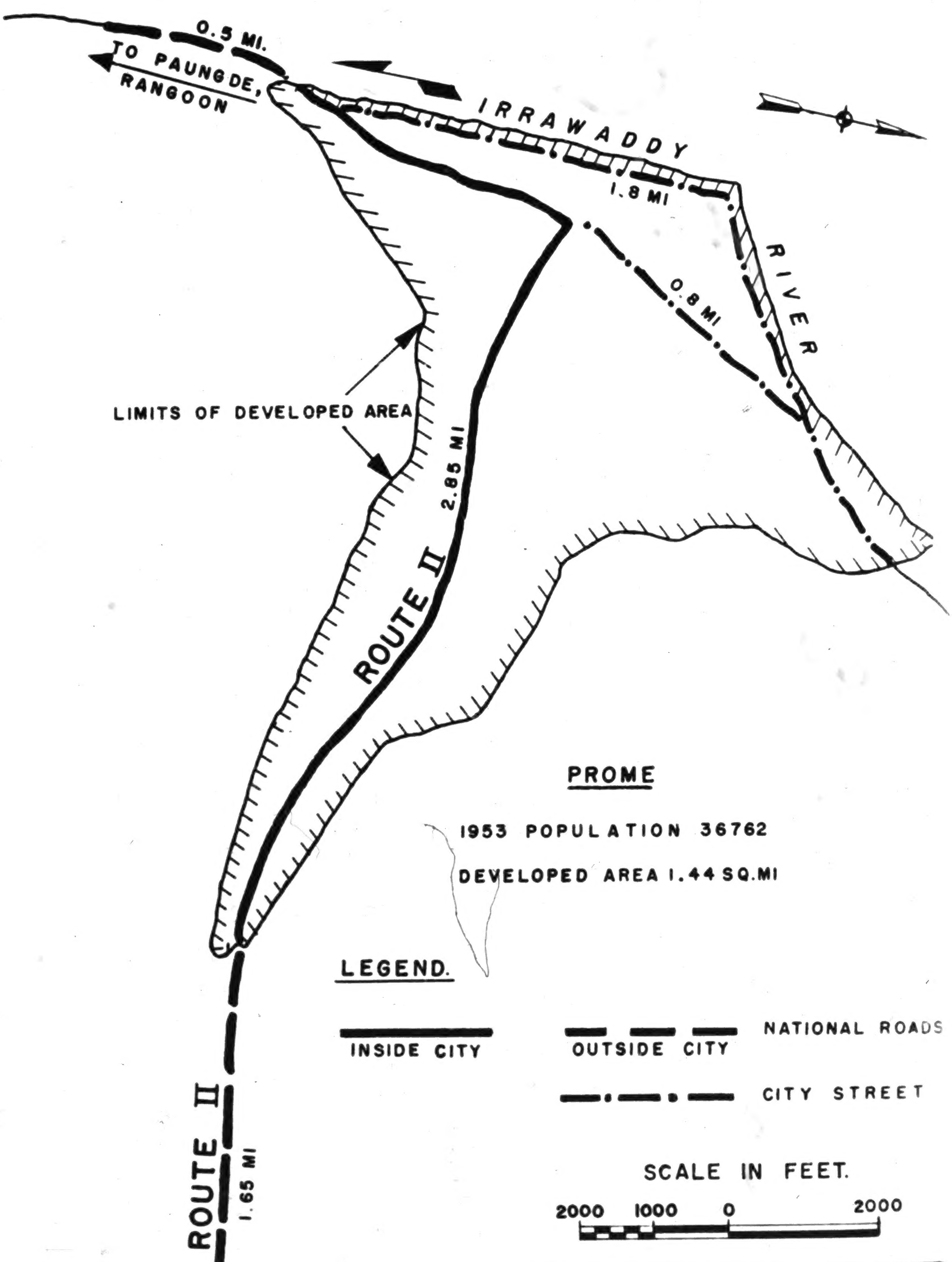
MINISTRY OF NATIONAL PLANNING

HIGHWAYS

LOCAL IMPROVEMENTS
PYINMANA

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON

DR. BY. E.J.P. DATE
CK. BY. K.B.W. JUNE 53. PLATE NO. 16


0.5 MI.
TO PAUNGDE, RANGOON
IRRAWADDY RIVER
1.8 MI
0.8 MI
LIMITS OF DEVELOPED AREA
2.85 MI
ROUTE II
ROUTE II
1.65 MI
TO MYINGYAN MANDALAY
LEGEND.
INSIDE CITY
OUTSIDE CITY
NATIONAL ROADS
CITY STREET
SCALE IN FEET.
2000
1000
0
2000

PROME

1953 POPULATION 36762

DEVELOPED AREA 1.44 SQ.MI

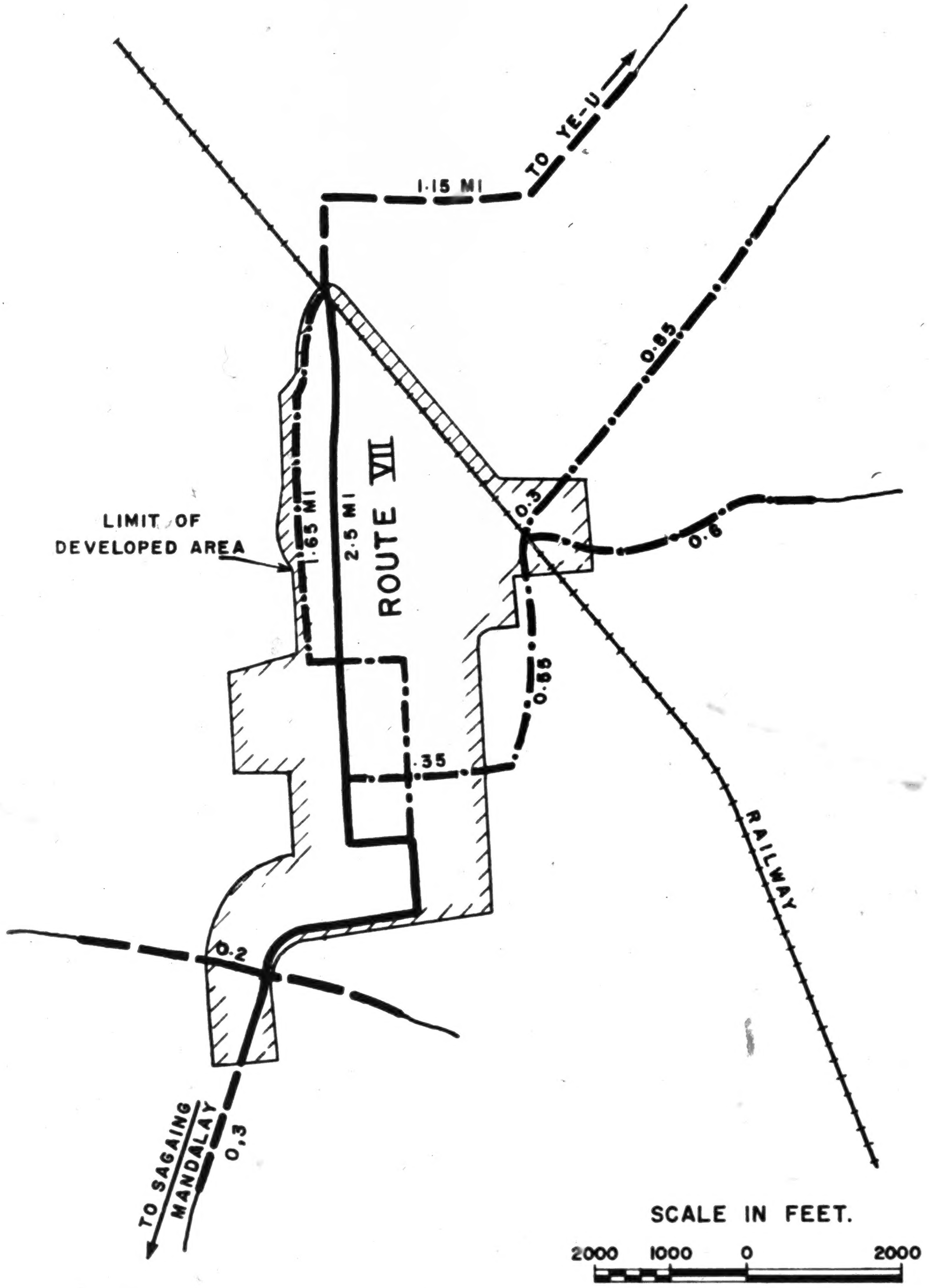
MINISTRY OF NATIONAL PLANNING

HIGHWAYS

LOCAL IMPROVEMENTS PROME

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON

DR. BY E.J.P. DATE
CK. BY. K.B.W. JUNE 53.
PLATE NO. 17


TO YE-U
1·15 MI
0·85
0·3
0·6
LIMIT OF DEVELOPED AREA
1·65 MI
2·5 MI
ROUTE VII
0·55
·35
RAILWAY
0·2
TO SAGAING MANDALAY
0,3
SCALE IN FEET.
2000
1000
0
2000

SHWEBO

1953 POPULATION 17827

DEVELOPED AREA — 0·86 SQ. MI.

LEGEND

NATIONAL ROADS: INSIDE CITY; OUTSIDE CITY

CITY STREET

MINISTRY OF NATIONAL PLANNING

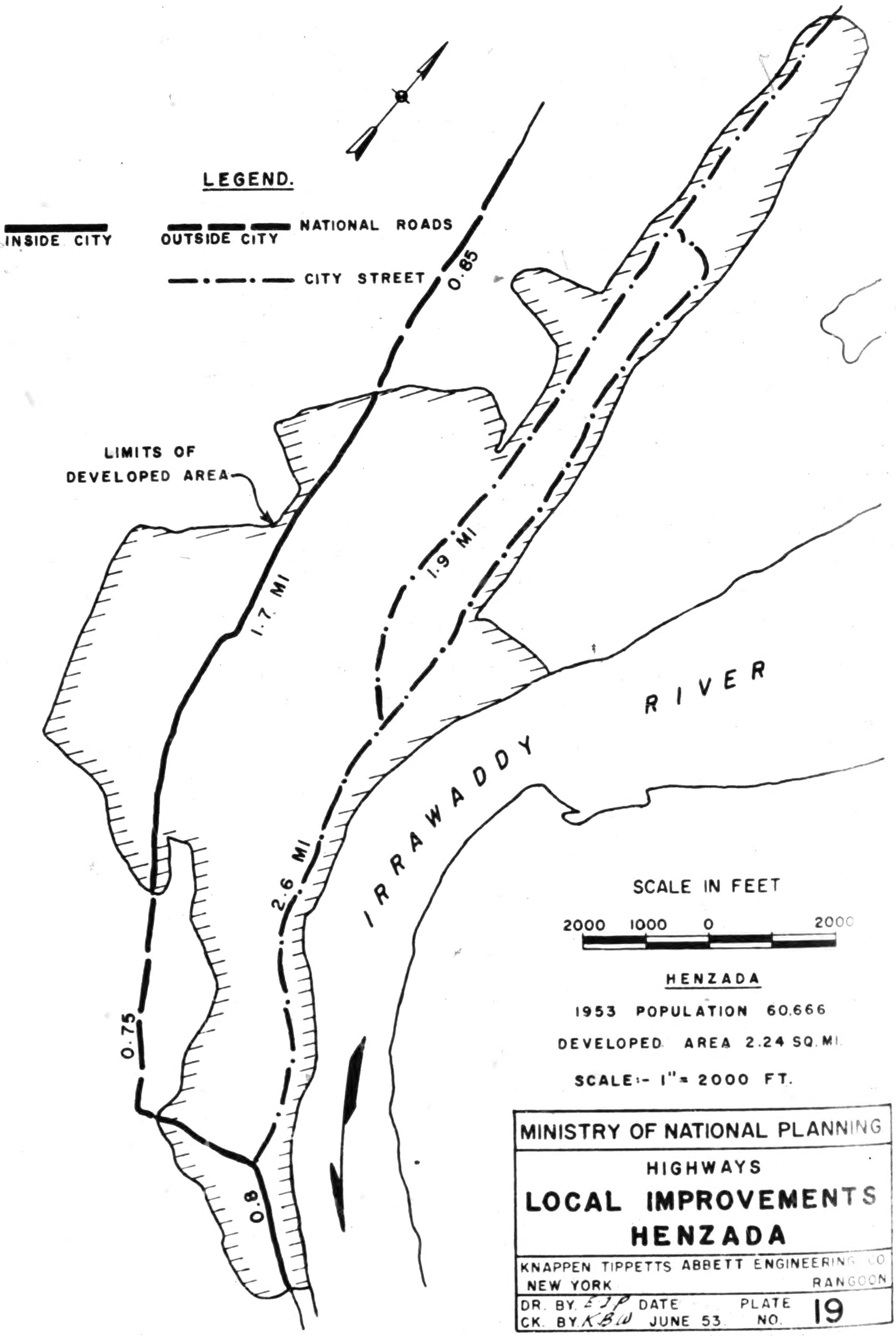
HIGHWAYS

LOCAL IMPROVEMENTS

SHWEBO

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. E.J.P. DATE PLATE NO. 18
CK. BY. KBW JUNE, 53.


LEGEND.
INSIDE CITY
OUTSIDE CITY
NATIONAL ROADS
CITY STREET
0.85
LIMITS OF DEVELOPED AREA
1.7 MI
1.9 MI
2.6 MI
0.75
0.8
IRRAWADDY RIVER
SCALE IN FEET
2000
1000
0
2000

HENZADA

1953 POPULATION 60,666

DEVELOPED AREA 2.24 SQ. MI.

SCALE:- 1" = 2000 FT.

MINISTRY OF NATIONAL PLANNING

HIGHWAYS

LOCAL IMPROVEMENTS
HENZADA

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. EJP DATE PLATE
CK. BY. KBW JUNE 53. NO. 19

TABLE XVI – 26

SUMMARY OF LOCAL IMPROVEMENTS ON DISTRICT AND SECONDARY ROADS*

		Mileage to be Improved		
	No. Communities	*On Distr. and Secondary Roads*	*On Local Streets*	*Total*
Cities and Towns Over 10,000	29	44	26	70
Towns and Villages under 10,000	125	108	37	145
Total		152	63	215

* In addition to the 34 towns and villages with populations under 10,000, as listed in Table XVI–25, there are other towns and villages of this size for which it is not possible at the present time to make an accurate estimate of the necessary local road and street improvement needs. As the general program develops, and as detailed surveys and planning get under way throughout the Union, it will be possible to extend the local improvement program to include work in each of these communities.

These smaller communities for which plans and estimates have not been prepared at present have populations from 10,000 down to 1,000. The total number of these is 90, of which 50 have a population of 3,000 or less.

It is estimated that for the 90 towns and villages 76 miles of district and secondary roads and 27 miles of town streets should be improved.

of the Union highway system. The principal function of the Department is that of constructing and maintaining buildings and the major portion of the budget for the past several years has been devoted to these activities. Roads have received approximately 10% of the budget and comparatively little attention from the Department. As a result no significant rehabilitation program has been undertaken or planned, and maintenance forces are not organized or equipped to cope with the rapid deterioration. During the next three decades a major reconstruction of the highway system must be carried out, and the proportions of the task will require the full attention of a well-staffed organization. It is recommended that a new Department of Roads be set up in the Ministry of Public Works or in the proposed new Ministry of Engineering Services and that the existing organization continue as the Department of Buildings. It is further recommended that this Department of Roads be staffed and equipped for actively pursuing a reconstruction program along the lines previously outlined in this chapter.

2. EQUIPMENT PROCUREMENT

The task of reconstruction ahead of the Department of Roads cannot be carried out expeditiously, if at all, by the traditional practices now being used in the limited road-work activities of the Department. The program ahead must be performed using sufficient road equipment to permit progress in highway rehabilitation, construction and maintenance to keep pace with the needs of the country. This equipment should not be procured prior to a thorough analysis of the needs of the rehabilitation program and the adoption of a schedule of progress.

After this has been done the equipment should be procured to fit the projects included in the plan and to carry out the work at the rates of progress adopted. Careful planning is necessary as a first step in any construction program, particularly when new practices and procedures are to be followed as would be the case when changing from manual to mechanical methods. To make the change successfully, it is not enough that the Department be furnished with machines; they must be the right machines for the work intended.

As previously recommended, and as shown in Table XVI–27, First Year Highway Program—Budget Requirements (*see next page*), it is proposed that the initial equipment purchases include two portable rock-crushing plants and an asphalt plant, together with the necessary laying equipment. It is also recommended that the Department workshops be enlarged and modernized, since this will be necessary in order to properly service the road-construction equipment. Also, work should be started on the materials laboratory, and funds have also been alloted for this purpose.

3. EQUIPMENT POLICY

It is recommended that the Department adopt as a general policy the use of road equipment to supplant hand labor in most of the work of grading and surfacing roads and building road structures.

4. PROGRAMMING

It is further recommended that the program be planned in detail before selecting the equipment and that the Department employ experienced advisers to assist in planning the work, procuring the equipment and putting it to use. The argument has been raised that the use of equipment will replace labor to the extent of creating technological unemployment. In this situation the work ahead of the Department is of such large proportions that it will use all present employees and many more for a considerable period of time. The general aspects of technological unemployment have been discussed in Chapter II.

5. UNION ROAD SYSTEM

It is recommended that work on the Union road system numbered routes be undertaken as promptly as possible by beginning with specific project planning

TABLE XVI – 27

FIRST YEAR HIGHWAY PROGRAM—BUDGET REQUIREMENTS

(all costs in (000) K)

	Total Program	*Miles*	*Total Costs*	*Local Costs*	*Foreign Costs*
General Projects	1,25,00		32,65	10,75	21,90
(*a*) Surveys—aggregate sources, soils stabilization, aerial surveys, traffic studies, etc.			7,25	3,95	3,30
(*b*) Planning			3,60	2,40	1,20
(*c*) Materials Testing Laboratory			50	40	10
(*d*) PWD Work Shops—enlargement and modernization			1,25	70	55
(*e*) Portable rock-crushing plants (2)			9,05	2,80	6,25
(*f*) Asphalt plant and laying equipment			11,00	50	10,50
Union Road System (3,135 mi.)	27,00,00		1,11,50	77,50	34,00
(*a*) Routes I and II rehabilitation and relocations		45	70,00	50,00	20,00
(*b*) Route III relocations		6	8,00	5,50	2,50
(*c*) Local improvements, 5 cities		23·5	28,50	20,00	8,50
(*d*) Patrol graders		—	5,00	2,00	3,00
		Say 75			
District Road System (6,750 mi.)	28,70,00		68,40	52,00	16,40
(*a*) Mandalay Division		45	18,00	14,40	3,60
(*b*) Magwe Division		30	11,90	9,10	2,80
(*c*) Pegu Division		40	14,50	10,50	4,00
(*d*) Local improvements, 8 cities		28·5	24,00	18,00	6,00
		Say 145			
Farm-to-market Roads (3,650 mi.)	20,00,00		90,00	75,00	15,00
(*a*) Grading, drainage		300	80,00	71,00	9,00
(*b*) Structures		—	10,00	4,00	6,00
Other Roads	5,00,00		30,00	25,50	4,50
(*a*) Loikaw–Pyinmana		50	15,00	12,75	2,25
(*b*) Access to Lough Keng Project		25	5,00	4,25	75
(*c*) ,, ,, Pegu Project, Dam Sites (3)		40	10,00	8,50	1,50
Total, 1953–54 Program			3,32,55	2,46,45	86,10
Total, Entire Program	81,95,00				

for the routes outlined in Table XVI–27 "First Year Highway Program—Budget Requirements." The initial work should include the rehabilitation and rebuilding where necessary of drainage structures, the rehabilitation of shoulders, and the widening of the paved surface, all to the standards outlined in Section F. This program should be extended from year to year until the full length of the 3,231 miles of numbered routes has been rebuilt. The yearly program must take cognizance of traffic requirements, and the work should be performed on the portions of the routes where traffic loads are the greatest. In Section Q, certain relocations are recommended which must be surveyed and estimated before making a decision as to whether to rehabilitate the existing road or to construct the new one.

6. DISTRICT ROAD SYSTEM

It is recommended that work on the district roads be undertaken as outlined and budgeted in Table

XVI–27. Rehabilitation should be performed to the standards outlined in Section F. Surveys must be made and planning for this work completed before any construction is undertaken. The total length of district roads is estimated to be 6,750 miles. This program should be continued from year to year to the ultimate completion. District roads are not subject to the traffic of those of the Union system; consequently are not as substantially surfaced. The traffic-bound surface will require well-organized maintenance after the newly built road has been put into operation or deterioration will occur.

7. FARM-TO-MARKET ROAD SYSTEM

The program for the first year for the entire system is shown in Table XVI–27. It is recommended that a planning program for the rebuilding of existing farm-to-market roads and the construction of new roads of this type be undertaken. These roads can be built with a relatively small amount of equipment, and progress in grading will be rapid under the supervision of an experienced grading foreman. The standards recommended are shown in Section F. Farm-to-market roads will be required in the irrigated areas, and should be planned in connection with the irrigation distribution system. The total length of this type of road estimated to be required is 3,650 miles and it is proposed that the initial construction total 300 miles, as budgeted in Table XVI–27. The maintenance of these roads could be arranged to be provided by the cultivators served, if surfacing rock is stockpiled at intervals along the roads and patrol graders are furnished periodically.

8. LOCAL IMPROVEMENT PROGRAM

As recommended in Section Q, a program of local improvements has been developed, after preliminary study for cities, towns and villages on the national routes and the district routes. The details are listed in Tables XVI–22 to XVI–26, and the budgetary requirements for the first year are included in the totals on Table XVI–27.

9. ACCESS ROADS

Other roads will have to be constructed in conjunction with new development work, such as access to project sites, mines and sources of raw materials in the forests and other locations. These will all involve new locations and construction. The tentative estimate of the required length of these roads is 1,400 miles. Most of them will be planned as a part of the project to which they give access, but will later be incorporated into the highway system. It is recommended that these highways which are to serve specific projects be planned jointly by the Department of Roads and the agency concerned with the project, and that during the construction of the project they be maintained by project forces. Upon project completion, maintenance and administration should be turned over to the Department of Roads. The standard to which they must be built will depend on the hauling anticipated during the project construction.

10. CONSTRUCTION METHODS

As recommended in Section G, studies should be undertaken to adopt the "road mix" and "plant mix" methods of modern highway construction to use in the Union of Burma. "Road mix" techniques are of special value in the construction of roads for low-density traffic.

11. MOTOR VEHICLE CODE

It is recommended that a Motor Vehicle Code following the general outline given in Section N be adopted.

12. SHOPS AND YARDS

It is recommended that the Department of Roads establish equipment yards and shops for the storage, repair and overhaul of construction and maintenance equipment, and that it modernize the existing facilities. The first shop should be established at Rangoon, and as the work program develops shops should be established at the district headquarters. The shops should be laid out by an equipment man experienced in handling and repairing road equipment.

13. CONTRACTS AND TRAINING

It is recommended that the initial construction contracts for the road program be awarded to foreign contractors experienced in highway construction. The contracts should contain specific provisions for training local superintendents, supervisors and equipment operators in the use and repair of highway equipment and in construction organization and procedures for road construction. Local contractors should be employed on subcontracts on the program, that they may become familiar with modern road construction methods and, as the program progresses, gain experience to enable them to carry on the larger contracts. The contract should provide for the submission and approval of specific training programs and schedules affording specific hours and methods of instruction for specified categories and numbers of personnel.

14. BUDGET REQUIREMENTS

The cost estimates for the recommended program of highway construction and rehabilitation have been summarized for the entire project, and developed in detail for the first year of the program. The totals, and items upon which early work should be undertaken, are shown in Table XVI–27.

While the program may have to be modified from year to year, as the overall economy and industrial potential of the Union develop, it is believed to be balanced.

Measured in terms of previous development of highways in Burma, this is an ambitious program. It is, however, one which is necessary if highway transport is to take its proper place beside rail, air and water.

CHAPTER XVII

AIRWAYS

A. INTRODUCTION

1. GENERAL

A farm-to-market country road will not satisfy express highway motor-freight traffic requirements. A cow-pasture landing strip will not support aircraft designed today for commercial passenger and freight traffic. The traveling public is as much, if not more, concerned in safe takeoff and landing as in safety of the aircraft in travel. The degree of acceptance of air travel is closely related to the appearance of the airstrip, airfield and facilities. The safe operation of aircraft is directly dependent upon the characteristics of many designs. For this reason, the International Civil Aviation Organization was set up by the United Nations to establish safe criteria for airports and aircraft maintenance and operation. The ICAO has established its minimal standards called "Recommendations for the Safe Design of Airports," basing these recommendations on the all-up weight and single wheel-load of aircraft. To achieve acceptably efficient and safe performance, the operations of Civil Air Transport by the Union of Burma Airways (UBA), and controls and designs by the Office of the Director of Civil Aviation (DCA) should comply with the recommendations of the ICAO.

2. PURPOSE AND SCOPE

This Report is concerned not only with the safe design of airports, but with the safe and economic operation of aircraft; the economic transportation of passengers and air freight, both air and land-borne; the accommodation of the traffic demand; and the development of the entire system of foreign and domestic airways serving Burma.

3. BACKGROUND INFORMATION

The following basic information will be helpful prior to discussing the structure and operations of Burma Airways:

(*a*) The Union of Burma Airways, hereafter referred to as the UBA, is the operating body of civil aviation in Burma.

(*b*) Internal civil aviation is a complete government monopoly.

(*c*) UBA has had sole control at all times of its freight and passenger rates, of its scheduling and operations, and of its routing.

(*d*) UBA chartered planes, not having aircraft to meet the need for service in the years ending October 1, 1949 and 1950, and was forced to pay the astounding sum in charter fees of 240 lakhs of Kyats. Had the chartered aircraft been available and been purchased, the fleet, even after depreciation, would be a very large asset today.

(*e*) UBA has had from its first operations the advice and guidance of technical experts of good repute.

Independence of the Union of Burma on January 4, 1948, found the new Government faced with many problems, among which communications and transport were of major importance. During the war all seaports had been mined at their entrances. Most of the important highway and railroad bridges had been destroyed, and the actual roadbeds devastated for great stretches. Air transport necessarily became of vital importance, and the airports and adjacent towns were made strongpoints by the Government. The airports have thus served both military and civil aviation, and continue to do so.

Civil Air Transport, UBA, has been privileged in this role and has materially benefited therefrom. Statements have been made that upon the complete cessation of hostilities Civil Aviation will fail. This has not been true in any other country, and should not be true in Burma. The natural mountain ranges lying nearly due north and south are an impediment to other than air travel east and west. In addition, a fast means of handling passenger and freight traffic the length of the country will always be in demand.

That civil aviation in Burma should be operated to throw the full cost upon the user is not entirely equitable, as the benefits of operation are both political and social; for example, the benefits of mail and express are shared by the entire country. The various ministries and district officials have been the UBA's best sources of revenue, so that not all the cost has been thrown directly upon the general public. That UBA expands into every district is desirable both for the solidarity of the Union and to meet economic needs.

The Director of Civil Aviation plans at least a temporary terminal at every airport, to be followed by permanent construction after cessation of active insurgency.

4. HISTORY AND ORGANIZATION

The Union of Burma Airways Board was originally constituted on March 23, 1948, and was reorganized on March 29, 1950. The Board was charged with the following duties:

(*a*) To provide rapid communication within Burma, and externally to adjacent countries.

(*b*) To speed the carriage of mails, essential supplies and urgent freight.

(*c*) To foster airmindedness.

(*d*) To develop a national air transport organization for both domestic and foreign operations.

Governmental administration of the Union of Burma Airways Board is under the Ministry of Transport and Communications. The Board's present composition is as follows:

Chairman.
General Manager.
Secretary, Ministry of Transport and Communications.
Secretary, Ministry of Finance and Revenue.
Director of Civil Aviation.

The first two are the operations chiefs of UBA who control the airline, the shops, the terminals, passenger and freight handling, transport to terminals from airports, rate fixing, accounting and fiscal and statistical matters. The fifth, the DCA, has no actual operations responsibility of or for the Union of Burma Airways.

The office of the DCA is a technical and administrative group responsible for the establishment and maintenance of the airports of Burma; the establishment of technical criteria for the loading, maintenance and operation of nonmilitary aircraft over and in Burma; the licensing of aircraft, pilots and aircraft mechanics and supervisors; the operation of the communication system for aircraft controls and signals; and the investigation of all nonmilitary aircraft accidents. The Meteorological Bureau supplies weather data for flight control and records of wind directions throughout Burma for use in orientation of new airstrips. The DCA, through contracts with the Public Works Departments of the various districts and with the Buildings and Roads Department, has programmed the continuous improvement and expansion of airports and their facilities.

Construction of the international airport and terminal facilities for Mingaladon at Rangoon is being accomplished by the Mingaladon Aerodrome Construction Committee under the direct supervision of the Ministry of Transport and Communications. The airstrip is newly completed and is serviceable for the largest transcontinental planes. It has attracted considerable new traffic from international airlines. The UBA operates a bus and freight service from its main terminal building in Rangoon to the airport.

The UBA and the international airlines contract the fueling of the planes to the Burmah Oil Corporation. The UBA maintains its own aircraft, handles all its bookings and freight shipments, and has responsible charge of all domestic and its own foreign service. The foreign service operates a total of ten flights weekly to Calcutta, Chittagong, Bangkok, Penang and Singapore.

B. INTERNATIONAL SERVICE

1. NEW CONSTRUCTION

The enabling laws creating and reorganizing airways operations in Burma stressed the requirement that international service be established and fostered. Accordingly, Mingaladon Airport at Rangoon has been reconstructed with a new main airstrip of concrete, 8,200 ft. by 200 ft., and an adjacent parallel taxiway, 8,200 ft. by 100 ft., also of concrete. A new airport operations building is now under construction. It is to be fully air-conditioned and is of the latest design. International air service is also flown to Mergui and Akyab, but only by UBA. These two airports are under reconstruction and new operations buildings are planned for immediate construction.

2. PRESENT OPERATIONS

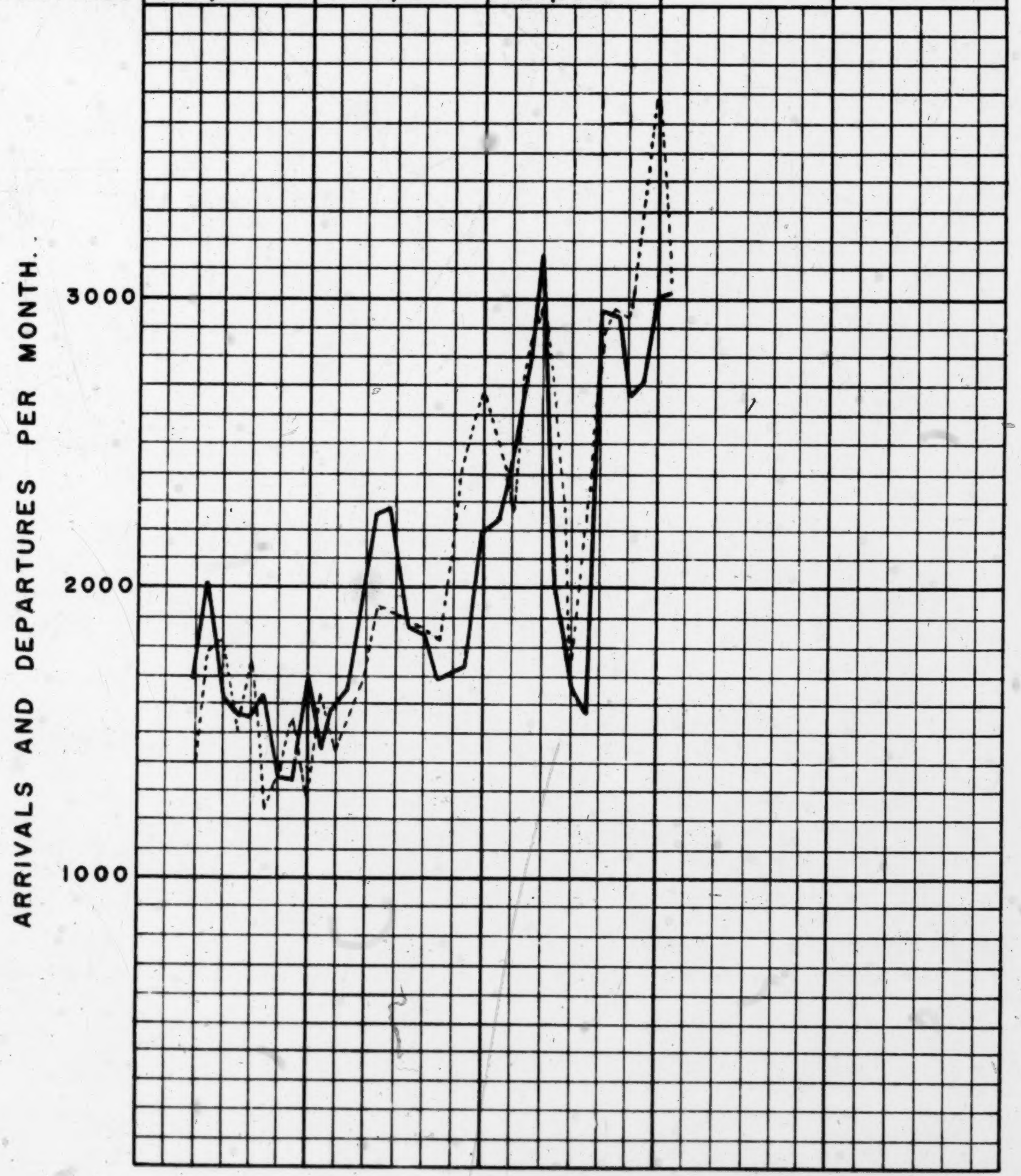
The following is the list of airlines furnishing international service to and from Burma. The first four listed are world airline services while the second four are confined to Asian service only.

	Operations Weekly
1. British Overseas Airways Corporation (BOAC)	9
2. Royal Dutch Airlines (KLM)	6
3. Pan American World Airways Incorporated (PAA)	2
4. Scandinavian Airlines System (SAS)	2
5. Union of Burma Airways (UBA)	10
6. Indian National Airways Limited (INA)	7
7. Thai Airways Company, Limited (THAI)	4
8. Orient Airways Limited (ORIENT)	3

Forty-three flights weekly into and out of Burma provide fast mail, passenger and freight service to nearby countries as well as round the world. BOAC is now operating a Comet jet-liner service which permits a passenger to depart at 12.45 on Saturdays from Rangoon, rest 12 hours at London Airport Sunday, and then, via its Monarch Service stratocruiser, arrive at 9 a.m. Monday in New York City. However, KLM,

YEARLY TOTALS

	1950	1951	1952	1953	1954
ARRIVALS	17,918	22,984	32,843		
DEPARTURES	18,706	22,107	29,958		



LEGEND

ARRIVALS SHOWN - - - - - - - - -

DEPARTURES SHOWN ————

MINISTRY OF NATIONAL PLANNING

MONTHLY INTERNATIONAL AIR PASSENGER TRAFFIC BURMA.

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. E.J.P. DATE MAY, 53. PLATE NO. 1
CK. BY. E.P.T.

without the use of jet liners, furnishes three flights easterly and westerly from Rangoon weekly, departing westerly at 11, 10 and 8.30 a.m., permitting six- to eight-hour rests at Amsterdam the following day, and arriving at noon in New York City the second day after departure. PAA have three flights weekly each way through the Far East, flying from New York City around the world to San Francisco in six days, and from San Francisco to New York City around the world in seven days because of international date-line time change. One flight per week each way calls at Rangoon and two flights overfly. When the service demands warrant, these over-flights will stop at Rangoon. Plate 1, showing monthly air passenger traffic through customs service from May 1950 through February 1953, indicates a steady growth of international air passenger traffic.

The UBA has recently acquired three Marathon Mark I aircraft primarily for international service. These planes make ten flights weekly. On Tuesdays and Fridays they fly a round trip from Rangoon to Bangkok, Thailand. Round-trip flights are made on Monday, Wednesday and Saturday from Rangoon via Akyab to Chittagong, East Pakistan. Round-trip flights from Rangoon via Akyab to Calcutta, India, are made on Tuesday, Thursday, Friday and Saturday. On Wednesday UBA has a flight to Singapore via Mergui and Penang which returns via these stops on Thursday.

3. SERVICE DELAYS

Delays in clearance of air freight may be attributed to dilatory handling of individual clearances by airways agents and to changes from scheduled flight departures. This sometimes results in freight being allowed to lie at intermediate terminals for as long as 12 days. This last condition applies to air mail as well to air freight and, although London is but 36 hours and New York 48 hours by air travel, mail takes 7 to 12 days. The Rangoon Post Office closes its air pouches to reception of air mail as much as 48 hours before departure time, while Mingaladon Airport is but 25 minutes driving time from the central Post Office. Also, air mail deposited in Mingaladon is returned to the central Post Office before being loaded aboard aircraft.

4. RECOMMENDATIONS

It is recommended that:

(*a*) The airlines establish an agency to prepare the necessary papers to clear air freight through customs. This service should be free to their air freight customers.

(*b*) Additional air freight and air mail franchises be granted to permit expeditious handling to and from all parts of the world.

(*c*) The Rangoon Post Office close its air pouches not sooner than two hours before departure time.

TABLE XVII – 1

POTENTIAL SUPPORT, VARIOUS BURMA DISTRICTS JUNE 6, 1948

District	*Division*	*Total Area Division (sq. mi.)*	*Area of District (sq. mi.)*	*1948 Acres in Cultivation in 1,000 Acres*
Akyab	Arakan	17,422	5,252	723
Arakan Hills Tract			3,228	456
Kyaukpyu			4,793	9
Sandoway			4,149	163
Rangoon	Pegu	20,221	85	27
Pegu			4,114	697
Tharrawaddy			2,782	576
Hanthawaddy			1,927	701
Insein			1,903	430
Prome			2,953	388
Toungoo			6,457	403
Bassein	Irrawaddy	13,580	4,149	754
Henzada			2,809	659
Maungmya			2,835	592
Maubin			1,642	410
Pyapon			2,145	433
Salween	Tenasserim	31,588	2,577	27
Thaton			4,872	691
Amherst			7,410	553
Tavoy			5,404	146
Mergui			11,325	169
Thayetmyo	Magwe	27,977	4,626	192
Minbu			3,602	263
Magwe			3,724	566
Pakokku			5,350	551
Chin Hills			10,675	NA
Mandalay	Mandalay	12,494	2,113	178
Kyaukse			1,241	194
Meiktila			2,232	488
Myingyan			2,707	687
Yamethin			4,201	416
Bhamo	Sagaing	72,911	4,180	23
Myitkyina			29,723	71
Shwebo			7,605	626
Sagaing			1,870	572
Katha			5,723	165
Upper Chindwin			10,599	114
Lower Chindwin			3,673	584
Naga Hills			9,535	NA
Northern Shan Sts.	Federated Shan Sts.	65,596	24,682	NA
Southern Shan Sts.			36,408	NA
Karenni States			4,506	NA
Total		261,789		

NA—Not available.

TABLE XVII – 2

UNION OF BURMA AIRWAYS

TIME TABLE

(Effective Wednesday, February 4, 1953)

DOMESTIC SCHEDULE SERVICES

	DAKOTA (Free Baggage: Domestic 44 lbs.)	*DEP.: MINGALADON*	*DOVE (Free Baggage: 25 lbs.)*	*DEP.: MINGALADON*
Monday				
	1. Mandalay–Bhamo–Myitkyina–Bhamo–Mandalay	0600	1. Bassein	0700
	2. Sandoway–Kyaukpyu–Akyab–Kyaukpyu–Sandoway	0645	2. Henzada	0705
	3. Moulmein	0715	3. Myaungmya	0915
	4. Mandalay	1000	4. Bassein	1130
	5. Tavoy–Mergui–Tavoy	1015		
Tuesday				
	1. Pakokku–Gangaw–Pakokku–Monywa–Mandalay	0630	1. Bassein	0700
	2. Magwe–Lanywa–Meiktila–Mandalay–Meiktila–Lanywa–Magwe	0645	2. Myaungmya	0915
	3. Moulmein	0715	3. Bassein	1130
	4. Loikaw–Heho–Mandalay–Heho–Loikaw	0730		
	5. Mandalay–Anisakan–Mandalay	1000		
Wednesday				
	1. Sandoway–Kyaukpyu–Akyab–Kyaukpyu–Sandoway	0645	1. Bassein	0700
	2. Mandalay–Lashio–Mandalay–Monywa–Mandalay	0710	2. Henzada	0705
	3. Moulmein–Tavoy–Mergui–Tavoy–Moulmein	0730	3. Thayetmyo–Magwe–Thayetmyo	0900
	4. Mandalay	1000	4. Myaungmya	0915
			5. Bassein	1130
			6. Moulmein	1400
Thursday				
	1. Mandalay–Bhamo–Myitkyina–Putao–Myitkyina–Bhamo–Mandalay	0600	1. Bassein	0700
	2. Mandalay–Monywa–Kalemyo–Monywa–Mandalay (Fortnightly extension to Singaling Khamti from Kalemyo w.e.f. 29-1-53)	0710 0605	2. Myaungmya	0915
	3. Moulmein	0715	3. Bassein	1130
	4. Heho–Keng Tung–Heho	0800		
	5. Mandalay	1000		
Friday				
	1. Magwe–Meiktila–Magwe	0600	1. Bassein	0700
	2. Pakokku–Pauk–Kyauktu–Pauk–Pakokku–Gangaw–Pakokku	0630	2. Myaungmya	0915
	3. Moulmein	0715	3. Bassein	1130
	4. Heho–Mandalay–Shwebo–Momeik–Shwebo–Mandalay	0730	4. Thaton	1400
	5. Mandalay–Anisakan–Mandalay	1000		
	6. Moulmein–Tavoy–Mergui–Tavoy–Moulmein	1015		
	7. Kyaukpyu–Akyab–Kyaukpyu	1230		
Saturday				
	1. Moulmein	0715	1. Bassein	0700
	2. Heho–Mandalay–Lashio–Mandalay–Heho	0730	2. Henzada	0705
	3. Mandalay–Monywa–Mandalay	1000	3. Thayetmyo–Magwe–Thayetmyo	0900
	4. Tavoy–Mergui–Tavoy	1015	4. Myaungmya	1915
			5. Bassein	0130
Sunday				
	1. Mandalay–Monywa–Kalemyo–Monywa–Mandalay	0700	1. Moulmein	0800
	2. Moulmein–Tavoy–Mergui–Tavoy–Moulmein	0730		
	3. *Loikaw–Heho–Mandalay	0830		

* Return Trip—Mandalay–Rangoon—purely freight service.
Note: This is "dry season" schedule and shows scheduled flights to all airports served.

C. DOMESTIC SERVICE

1. HISTORY

The UBA operates to 32 airports from Mingaladon, with some daily and some weekly and fortnightly flights. The service cannot be considered adequate as fast transport of passenger, mail, freight and news service is needed for both public and private purposes. Many districts, encompassing great areas of the country, are without any airline service. The valley of the Irrawaddy, for a distance of 200 miles between Mandalay and Bhamo, is without an airport. The valley of the Chindwin between Kalemyo and Singaling Khamti, a distance of 300 miles, is unserved. The northern, southern and eastern Shan States with a total area in excess of 60,000 square miles, 25% of the total area of the Union, have but one airport each. To be sure, some unserved areas are under insurgent control or are otherwise presently unsafe for operations. The entire valley of the Salween River, a distance of 650 miles north from Moulmein to the Yunnan, China, border, is unserved by UBA because of these hostilities. Lumbering operations are nearly at a standstill on this river, and mining and quarrying operations entirely so. At some airstrips, the villages immediately across the river are insurgent-controlled, with the airstrip held by GUB military. Until these conditions are relieved, any plan for improved service must be accompanied by a suitable security plan.

2. FLIGHT SCHEDULES AND FARES

Table XVII–2 presents a weekly schedule of domestic flight operations and Plate 2 shows the flight operations to individual airports. The schedule of fares, single and round trips, excess baggage rates, and freight rates charged by UBA on its domestic system are shown in Tables XVII–3 and XVII–4. Table XVII–5 presents the areas, airports and numbers of flights for the border and northern states.

3. DEFICIENCIES

Frequent flights over the UBA system, coupled with a study of all available data, lead to the following observations:

(*a*) The balance-sheet (see Table XVII–15, p. 484) indicates that the rates set by UBA are adequate and are needed to support the large program of airport reconstruction and equipment replacement, construction of new airports in the border states, and increase in aircraft fleet.

(*b*) UBA is operating with insufficient aircraft and as a consequence is unable to give the frequency of service needed and handle the full traffic volume. Two illustrations drawn at random illustrate this situation. On February 3, 1953, on a return flight from the airstrip at Tavoy ten would-be passengers for Rangoon had to be left behind. On February 19, 1953, five military personnel and one civilian were refused booking from Heho to Keng Tung because the all-up weight was at the limit. There is only one flight per week between Heho and Keng Tung.

TABLE XVII – 3

UBA—FARES, BAGGAGE AND FREIGHT RATES

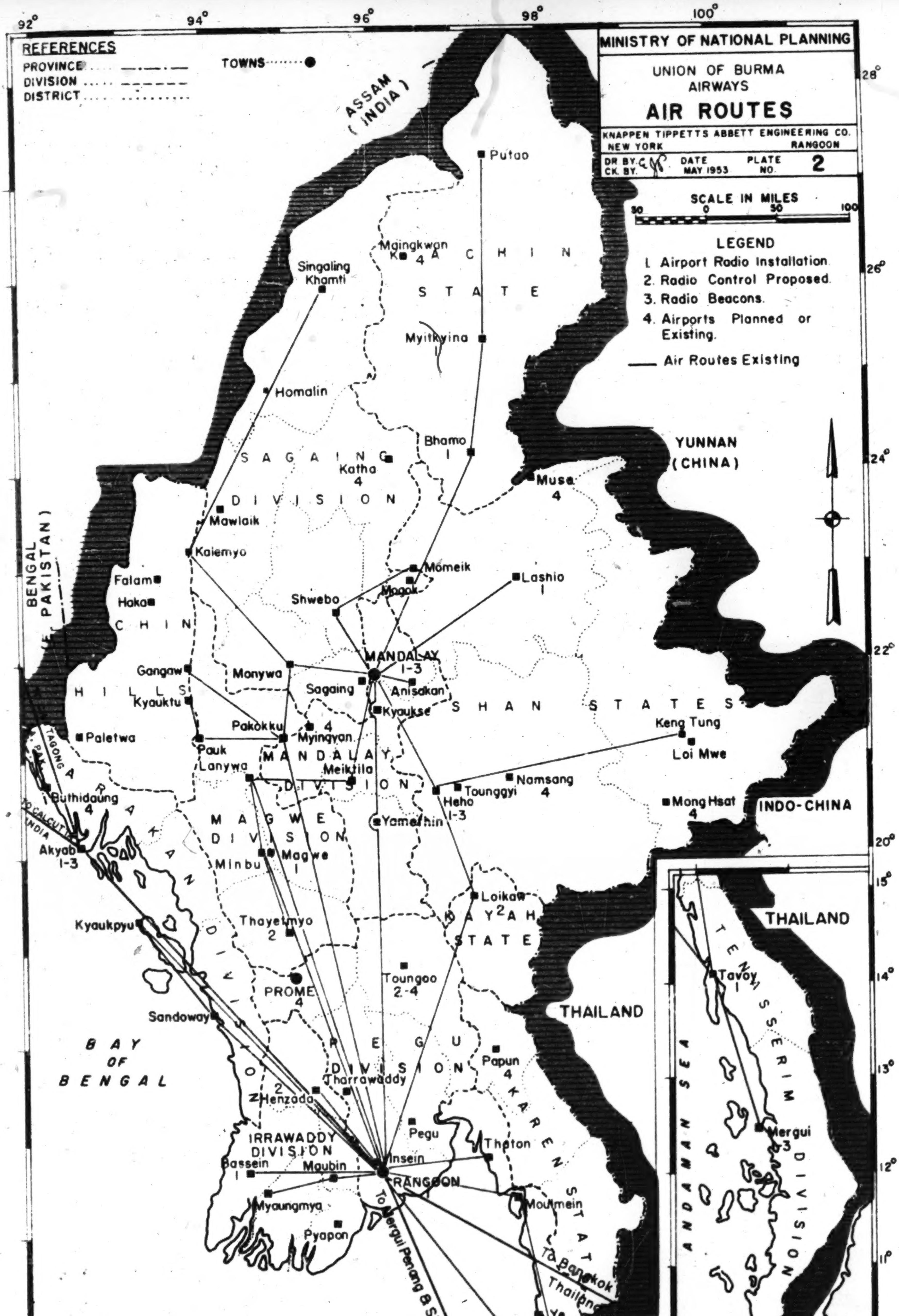
Rangoon to	*Single Fares (kyats)*	*Return Fares (kyats)*	*Excess Baggage per lb. (kyats)*	*Freight Rates per lb. (kyats)*
Akyab	95.00	180.50	0.40	0.30
Anisakan	105.00	199.50	0.45	0.40
Anisakan via Mandalay	120.00	228.00	0.50	0.45
Bassein	35.00	66.50	0.20	0.20
Bhamo	170.00	325.00	0.75	0.65
Gangaw	115.00	218.50	0.50	0.45
Heho	85.00	161.50	0.40	0.30
Henzada	30.00	57.00	0.20	0.20
Kalemyo	140.00	266.00	0.65	0.55
Keng Tung	135.00	256.50	0.65	0.55
Kyaukpyu	75.00	142.50	0.30	0.25
Kyauktu	105.00	199.50	0.45	0.40
Lanywa	90.00	171.00	0.40	0.30
Lashio	140.00	266.00	0.65	0.55
Loikaw	70.00	133.00	0.30	0.25
Magwe	75.00	142.50	0.30	0.25
Mandalay	105.00	199.50	0.45	0.40
Meiktila	85.00	161.50	0.40	0.30
Mergui	115.00	218.50	0.50	0.45
Monywa	110.00	209.00	0.50	0.45
Moulmein	35.00	66.50	0.20	0.20
Myaungmya	30.00	57.00	0.20	0.20
Momeik	150.00	285.00	0.75	0.65
Myitkyina	195.00	370.50	0.90	0.75
Pakokku	100.00	190.00	0.45	0.40
Pauk	100.00	190.00	0.45	0.40
Putao	241.00	457.90	1.05	0.90
Sandoway	51.00	96.90	0.30	0.25
Shwebo	122.00	231.80	0.50	0.45
Tavoy	80.00	152.00	0.40	0.30
Thaton	30.00	57.00	0.20	0.20
Toungoo	40.00	76.00	0.20	0.20

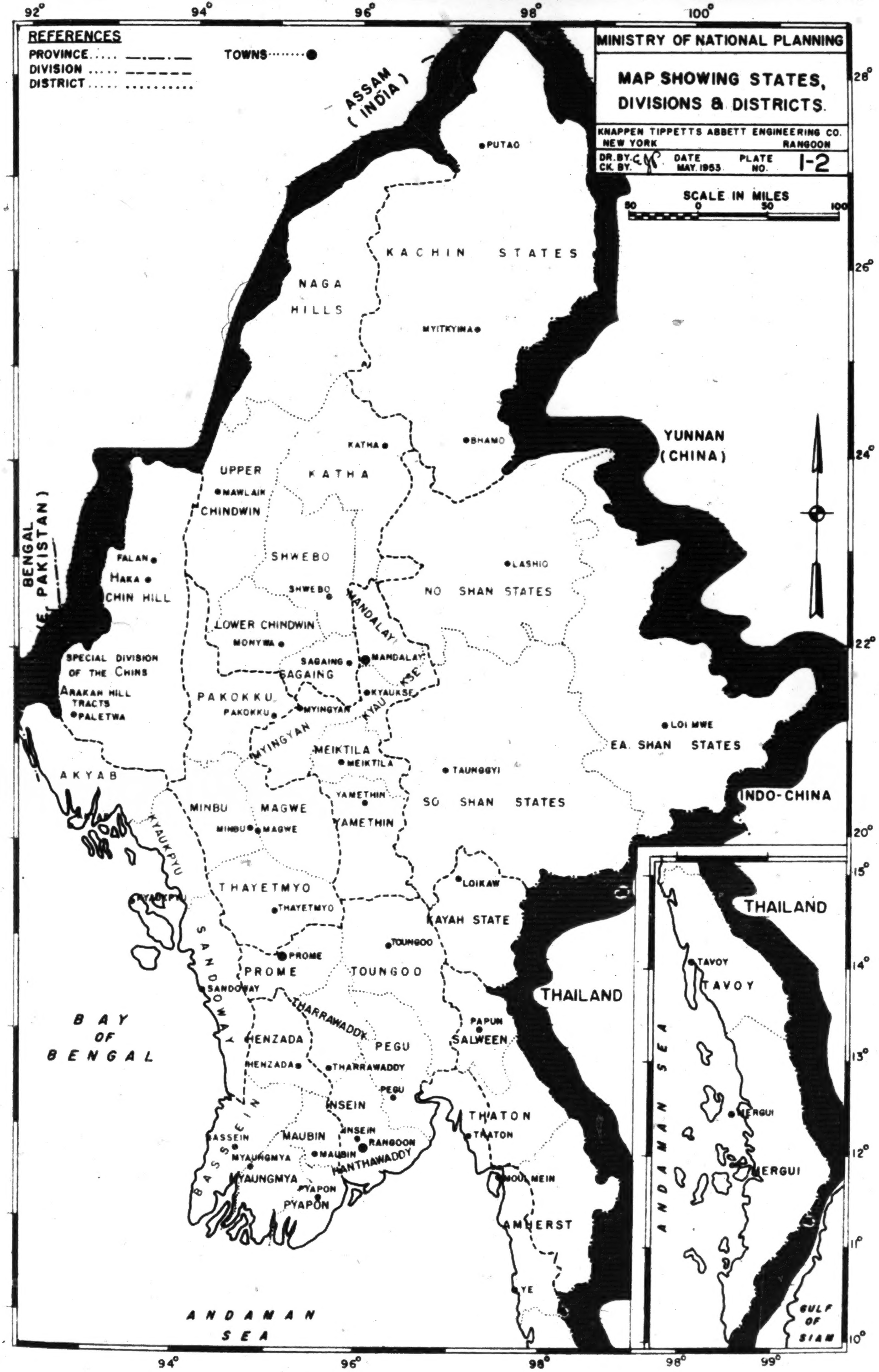
(*c*) The lack of radio at certain airports and the consequent lack of information on seats available makes it necessary for the UBA representatives at these airports to wait until the flight is in before accepting bookings. In other words, the average passenger has no knowledge, until the last several minutes, as to whether he will or will not be sold a ticket.

(*d*) As indicated by Table XVII–5, 127,300 of the 262,000 square miles of Burma have very poor air service.

4. RECOMMENDATIONS

(*a*) Test flights, advertised in advance, should be made to the airports presently served, to obtain an indication of whether an increase in traffic will result.


MINISTRY OF NATIONAL PLANNING
UNION OF BURMA
AIRWAYS
AIR ROUTES
KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK
RANGOON
DR. BY. C
CK. BY.
DATE
MAY 1953
PLATE
NO.
2
SCALE IN MILES
50
0
50
100
LEGEND
1. Airport Radio Installation.
2. Radio Control Proposed.
3. Radio Beacons.
4. Airports Planned or Existing.
Air Routes Existing
REFERENCES
PROVINCE
DIVISION
DISTRICT
TOWNS
92°
94°
96°
98°
100°
28°
26°
24°
22°
20°
ASSAM (INDIA)
BENGAL (E. PAKISTAN)
YUNNAN (CHINA)
INDO-CHINA
THAILAND
KACHIN STATE
SAGAING DIVISION
CHIN HILLS
ARAKAN DIVISION
MAGWE DIVISION
MANDALAY DIVISION
SHAN STATES
KAYAH STATE
PEGU DIVISION
KAREN STATE
IRRAWADDY DIVISION
BAY OF BENGAL
ANDAMAN SEA
Putao
Mgingkwan
4
Singaling Khamti
Myitkyina
Homalin
Bhamo
1
Katha
4
Muse
4
Mawlaik
Kalemyo
Falam
Haka
Momeik
Mogok
Lashio
1
Shwebo
MANDALAY
1-3
Monywa
Sagaing
Anisakan
Gangaw
Kyauktu
Kyaukse
Pakokku
4
Myingyan
Paletwa
Pauk
Lanywa
Meiktila
Keng Tung
Loi Mwe
Heho
1-3
Taunggyi
Namsang
4
Mong Hsat
4
Buthidaung
4
TO CALCUTTA INDIA
Akyab
1-3
Yamethin
Minbu
Magwe
1
Loikaw
2
Kyaukpyu
Thayetmyo
2
Toungoo
2-4
PROME
4
Sandoway
Papun
4
2
Henzada
Tharrawaddy
Pegu
Thaton
Bassein
1
Maubin
Insein
RANGOON
Moulmein
Myaungmya
Pyapon
To Mergui Penang & Singapore
To Bangkok Thailand
Ye
TAGONG
ANDAMAN SEA
TENASSERIM DIVISION
Tavoy
1
Mergui
3
Victoria Point
4
GULF OF SIAM
15°
14°
13°
12°
11°
10°
98°
99°


MINISTRY OF NATIONAL PLANNING

MAP SHOWING STATES, DIVISIONS & DISTRICTS.

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. CK. BY. DATE MAY. 1953. PLATE NO. 1-2

REFERENCES
PROVINCE
DIVISION
DISTRICT
TOWNS
SCALE IN MILES
50 0 50 100
92°
94°
96°
98°
100°
28°
26°
24°
22°
20°
ASSAM (INDIA)
PUTAO
KACHIN STATES
NAGA HILLS
MYITKYINA
YUNNAN (CHINA)
KATHA
BHAMO
UPPER CHINDWIN
MAWLAIK
BENGAL (E. PAKISTAN)
FALAN
HAKA
CHIN HILL
SHWEBO
LASHIO
NO SHAN STATES
MANDALAY
LOWER CHINDWIN
MONYWA
SPECIAL DIVISION OF THE CHINS
ARAKAN HILL TRACTS
PALETWA
SAGAING
PAKOKKU
KYAUKSE
MYINGYAN
MEIKTILA
LOI MWE
EA. SHAN STATES
TAUNGGYI
AKYAB
YAMETHIN
SO SHAN STATES
INDO-CHINA
MINBU
MAGWE
KYAUKPYU
THAYETMYO
LOIKAW
KAYAH STATE
SANDOWAY
TOUNGOO
PROME
THAILAND
BAY OF BENGAL
THARRAWADDY
PAPUN
SALWEEN
HENZADA
PEGU
INSEIN
THATON
BASSEIN
MAUBIN
RANGOON
MYAUNGMYA
HANTHAWADDY
PYAPON
MOULMEIN
AMHERST
YE
ANDAMAN SEA
15°
14°
13°
12°
11°
10°
98°
99°
TAVOY
MERGUI
GULF OF SIAM

TABLE XVII – 4

UBA—FARES AND EXCESS BAGGAGE RATES

(Intermediate Stations)
Effective July 1, 1952.

From/To	*Single (kyats)*	*Return (kyats)*	*Excess Baggage per lb. (kyats)*	*Freight Rate per lb. (kyats)*
Akyab-Kyaukpyu	22.00	41.80	0.20	0.20
Bassein-Henzada	25.00	47.50	0.20	0.20
Bassein-Myaungmya	13.50	25.65	0.20	0.20
Bhamo-Mandalay	65.00	123.50	0.30	0.25
Bhamo-Myitkina	26.00	49.40	0.20	0.20
Bhamo-Putao	70.00	133.00	0.40	0.25
Gangaw-Kyauktu	20.00	38.00	0.20	0.20
Gangaw-Pakokku	35.00	66.50	0.20	0.20
Gangaw-Pauk	30.00	57.00	0.20	0.20
Gangaw-Lanywa	35.00	66.50	0.20	0.20
Gangaw-Monywa	45.00	85.50	0.25	0.20
Gangaw-Mandalay	65.00	123.50	0.30	0.25
Heho-Loikaw	25.00	47.50	0.20	0.20
Heho-Mandalay	35.00	66.50	0.20	0.20
Heho-Keng Tung	60.00	144.00	0.30	0.25
Heho-Lashio	70.00	133.00	0.40	0.30
Heho-Toungoo	40.00	76.00	0.20	0.20
Heho-Momeik	80.00	152.00	0.45	0.40
Kalemyo-Mandalay	48.00	91.20	0.25	0.20
Kalemyo-Monywa	35.00	66.50	0.20	0.20
Keng Tung-Loikaw	65.00	123.50	0.30	0.25
Kyauktu-Pauk	12.50	23.75	0.20	0.20
Kyauktu-Gangaw	20.00	38.00	0.20	0.20
Kyauktu-Pakokku	30.00	57.00	0.20	0.20
Kyauktu-Lanywa	19.00	36.10	0.20	0.20
Katha-Rangoon	170.00	323.00	0.75	0.65
Katha-Mandalay	55.00	104.50	0.30	0.25
Katha-Meiktila	80.00	152.00	0.45	0.40
Katha-Myitkyina	40.00	76.00	0.20	0.20
Lanywa-Mandalay	40.00	76.00	0.20	0.20
Lanywa-Meiktila	25.00	47.50	0.20	0.20
Lanywa-Pakokku	20.00	38.00	0.20	0.20
Lashio-Mandalay	40.00	76.00	0.20	0.20
Loikaw-Mandalay	55.00	104.50	0.25	0.20
Magwe-Mandalay	45.00	85.50	0.20	0.20
Magwe-Meiktila	25.00	47.50	0.20	0.20
Magwe-Lanywa	25.00	47.50	0.20	0.20
Mandalay-Anisakan	15.00	28.50	0.20	0.20
Mandalay-Meiktila	25.00	47.50	0.20	0.20
Mandalay-Monywa	25.00	47.50	0.20	0.20
Mandalay-Momeik	45.00	85.50	0.30	0.25
Mandalay-Myitkyina	95.00	180.50	0.40	0.30
Mandalay-Shwebo	19.00	36.10	0.20	0.20
Mandalay-Pakokku	30.00	57.00	0.20	0.20
Mandalay-Putao	125.00	237.50	0.50	0.45
Mandalay-Toungoo	65.00	123.50	0.30	0.25
Meiktila-Pakokku	25.00	47.50	0.20	0.20
Meiktila-Toungoo	45.00	85.50	0.20	0.20
Meiktila-Myitkyina	120.00	228.00	0.50	0.45
Mergui-Moulmein	93.00	176.70	0.40	0.30
Mergui-Tavoy	40.00	76.00	0.20	0.20
Momeik-Bhamo	35.00	66.50	0.20	0.20
Momeik-Myitkyina	55.00	104.50	0.30	0.25
Monywa-Meiktila	30.00	57.00	0.20	0.20
Moulmein-Tavoy	55.00	104.50	0.25	0.20
Moulmein-Thaton	15.00	28.50	0.20	0.20
Myitkyina-Putao	40.00	76.00	0.20	0.20
Pakokku-Pauk	25.00	47.50	0.20	0.20
Pauk-Lanywa	25.00	47.50	0.20	0.20
Pakokku-Monywa	25.00	47.50	0.20	0.20
Shwebo-Momeik	30.00	57.00	0.20	0.20

TABLE XVII – 5

FLIGHT DATA FOR BORDER AND NORTHERN STATES

District or State	*Area (sq. mi.)*	*Airport*	*Flights Weekly*
Southern Shan States	25,000	Heho	4
Eastern Shan States	19,900	Keng Tung	1
Northern Shan States	16,200	Lashio and Momeik	1
Myitkyina	29,700	Putao and Myitkyina	2
Naga Hills	9,500	Singaling Khamti	*
Upper Chindwin	10,600	Kalemyo	1
Katha	5,700	Katha	0
Special Division of the Chin Hills	10,000	None	0
Total Area	127,300		

* Fortnightly.

Table XVII–1, showing the potential support value of the various districts, and Plate 1–2, showing the district locations, together indicate which of the present airfields most need increases in service.

(*b*) An airstrip should be constructed at Homalin, approximately halfway between Singaling Khamti and Kalemyo, to serve the valley of the Chindwin.

(*c*) Immediately upon securing the area, the Papun airstrip should be developed and flights scheduled.

(*d*) A survey should be made of the special division of the Chin Hills to determine the most advantageous location for an airstrip from the viewpoints of population and business. Immediate programming of the construction should follow this survey.

D. PERSONNEL

The personnel organization of the various departments is presented in Tables XVII–6 through XVII–10.

1. OBSERVATIONS

(*a*) Less than 5% of the entire organization is non-national, this group consisting of most of the pilots and department heads of the Flight Operations and Maintenance Departments.

(*b*) Table XVII–6 (*see next page*) presents the organization for UBA as originally presented in the Preliminary Report. No changes are recommended.

(*c*) Table XVII–7 presents the organization for the Operations and Maintenance Departments of UBA.

(1) *The Operations Department* presently has a staff of 42, headed by the Chief Pilot. There are 12 pilots, 13 co-pilots, and 13 radio operators to operate the fleet, which consists of eight Dakotas, three Doves, three Marathons, and two Consuls, 16 planes in all. It would appear that 25% of the fleet is grounded at all times.

TABLE XVII-6

ORGANIZATION CHART UNION OF BURMA AIRWAYS

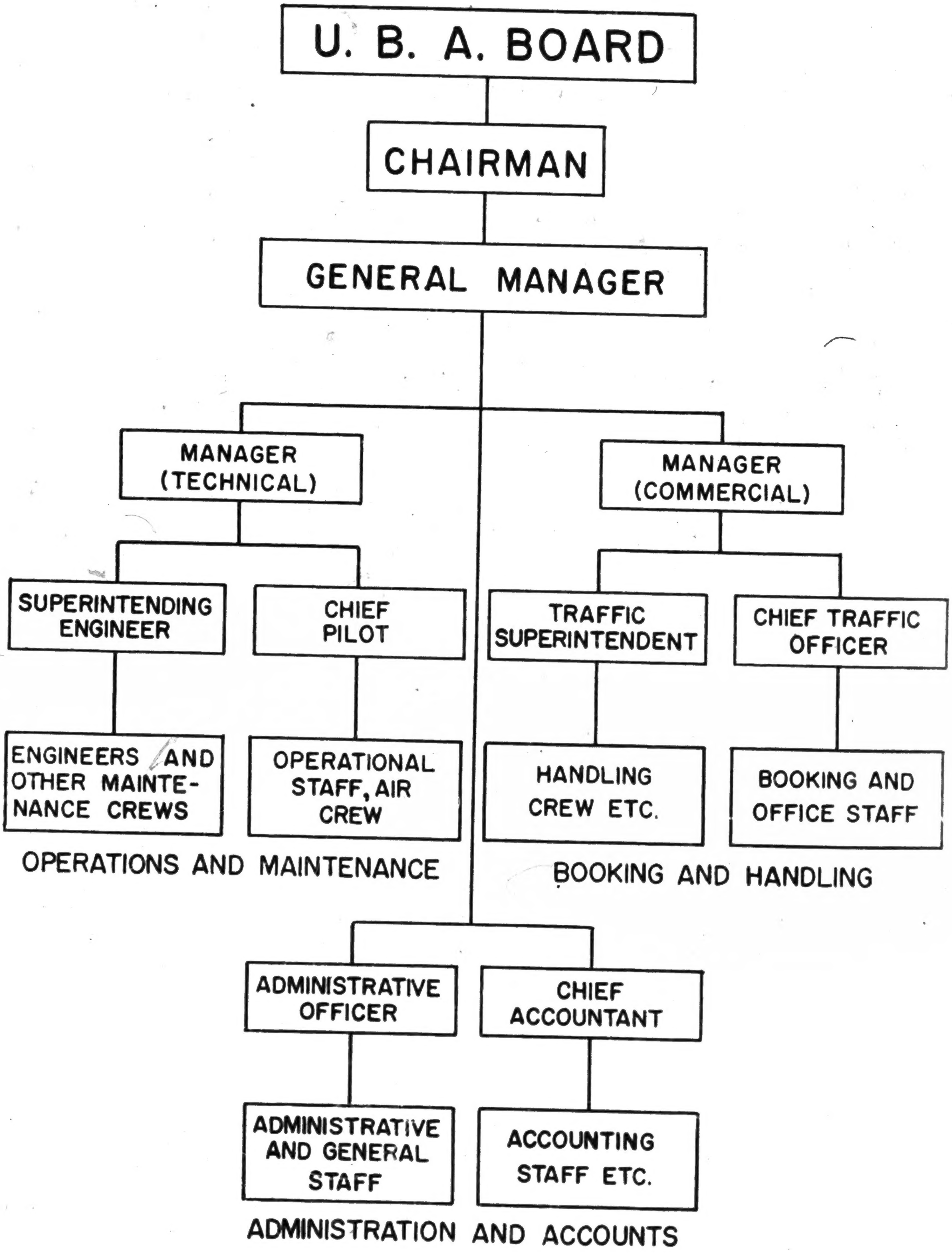
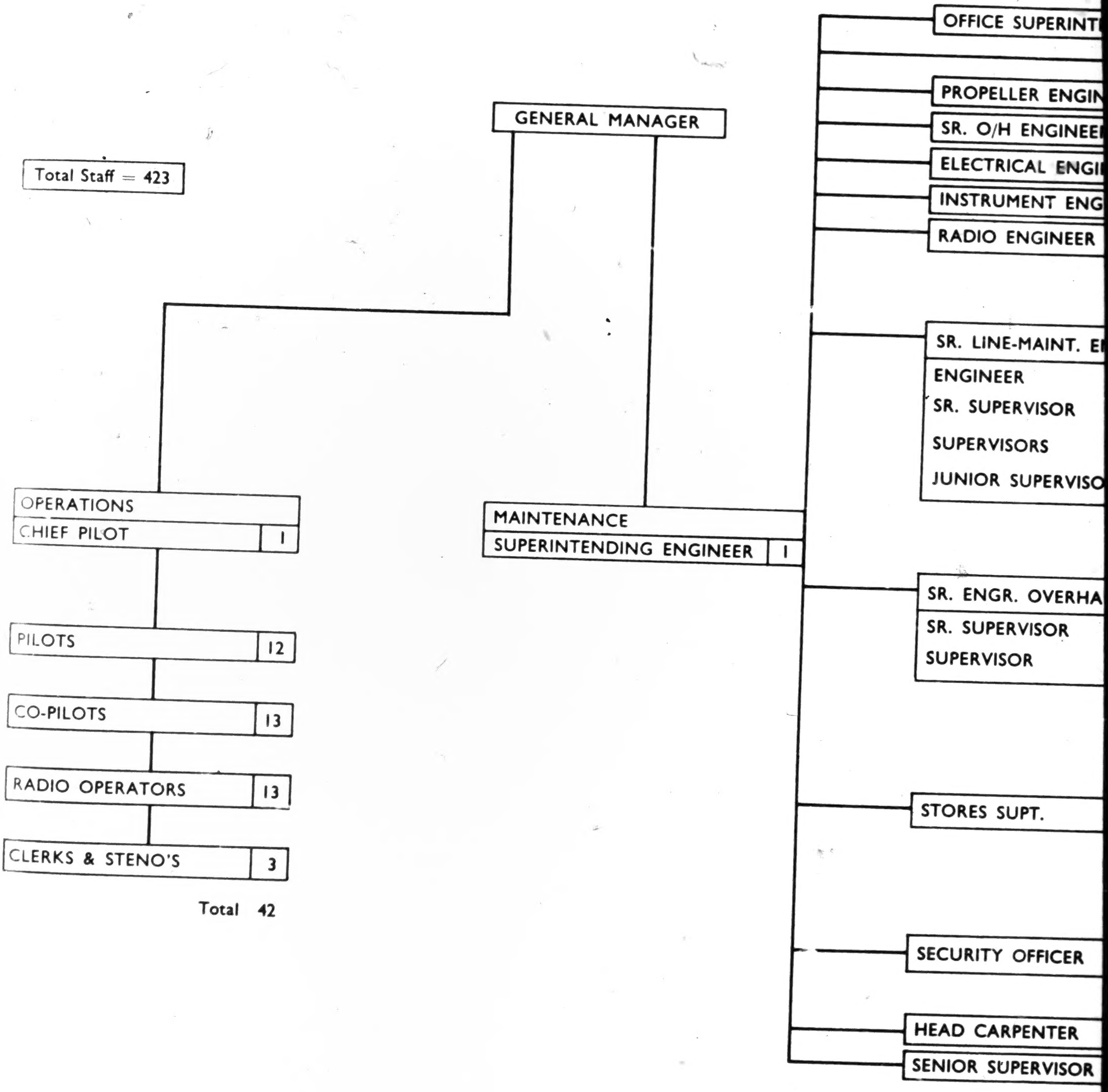

U. B. A. BOARD
CHAIRMAN
GENERAL MANAGER
MANAGER (TECHNICAL)
MANAGER (COMMERCIAL)
SUPERINTENDING ENGINEER
CHIEF PILOT
TRAFFIC SUPERINTENDENT
CHIEF TRAFFIC OFFICER
ENGINEERS AND OTHER MAINTENANCE CREWS
OPERATIONAL STAFF, AIR CREW
HANDLING CREW ETC.
BOOKING AND OFFICE STAFF
OPERATIONS AND MAINTENANCE
BOOKING AND HANDLING
ADMINISTRATIVE OFFICER
CHIEF ACCOUNTANT
ADMINISTRATIVE AND GENERAL STAFF
ACCOUNTING STAFF ETC.
ADMINISTRATION AND ACCOUNTS

TABLE XVII-7

ORGANIZATION CHART

UNION OF BURMA AIRWAY

OPERATIONS & MAINTENANCE DEPARTME


GENERAL MANAGER
Total Staff = 423
OPERATIONS
CHIEF PILOT 1
PILOTS 12
CO-PILOTS 13
RADIO OPERATORS 13
CLERKS & STENO'S 3
Total 42
MAINTENANCE
SUPERINTENDING ENGINEER 1
OFFICE SUPERINT
PROPELLER ENGIN
SR. O/H ENGINEE
ELECTRICAL ENGI
INSTRUMENT ENG
RADIO ENGINEER
SR. LINE-MAINT. E
ENGINEER
SR. SUPERVISOR
SUPERVISORS
JUNIOR SUPERVISO
SR. ENGR. OVERHA
SR. SUPERVISOR
SUPERVISOR
STORES SUPT.
SECURITY OFFICER
HEAD CARPENTER
SENIOR SUPERVISOR

* Three 8-hour Shifts

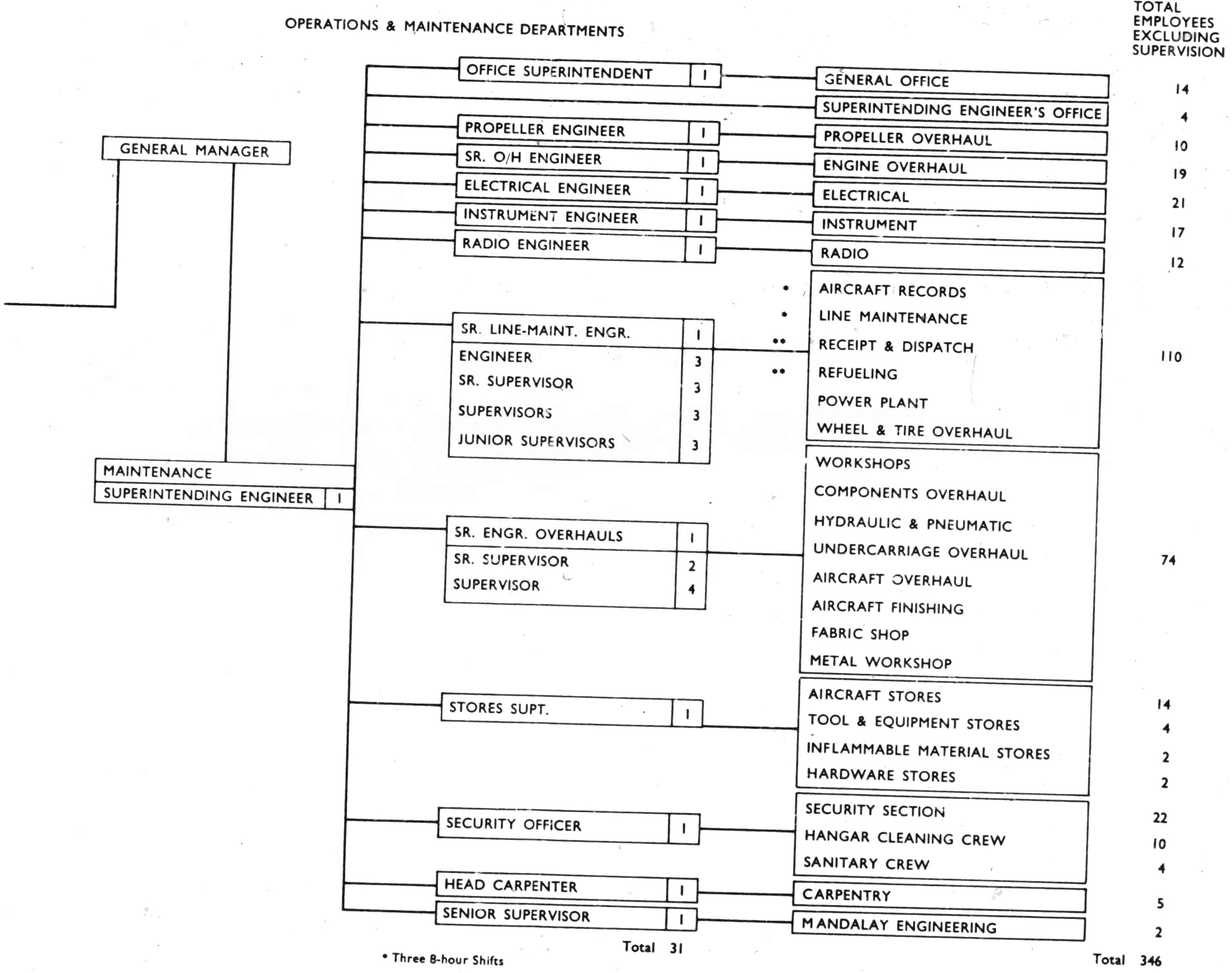
** Two 8-hour Shifts

TABLE XVII - 7

ORGANIZATION CHART

UNION OF BURMA AIRWAYS

OPERATIONS & MAINTENANCE DEPARTMENTS


TOTAL EMPLOYEES EXCLUDING SUPERVISION
GENERAL MANAGER
MAINTENANCE
SUPERINTENDING ENGINEER 1
OFFICE SUPERINTENDENT 1
GENERAL OFFICE 14
SUPERINTENDING ENGINEER'S OFFICE 4
PROPELLER ENGINEER 1
PROPELLER OVERHAUL 10
SR. O/H ENGINEER 1
ENGINE OVERHAUL 19
ELECTRICAL ENGINEER 1
ELECTRICAL 21
INSTRUMENT ENGINEER 1
INSTRUMENT 17
RADIO ENGINEER 1
RADIO 12
SR. LINE-MAINT. ENGR. 1
ENGINEER 3
SR. SUPERVISOR 3
SUPERVISORS 3
JUNIOR SUPERVISORS 3
* AIRCRAFT RECORDS
* LINE MAINTENANCE
** RECEIPT & DISPATCH
** REFUELING
POWER PLANT
WHEEL & TIRE OVERHAUL
110
SR. ENGR. OVERHAULS 1
SR. SUPERVISOR 2
SUPERVISOR 4
WORKSHOPS
COMPONENTS OVERHAUL
HYDRAULIC & PNEUMATIC
UNDERCARRIAGE OVERHAUL
AIRCRAFT OVERHAUL
AIRCRAFT FINISHING
FABRIC SHOP
METAL WORKSHOP
74
STORES SUPT. 1
AIRCRAFT STORES 14
TOOL & EQUIPMENT STORES 4
INFLAMMABLE MATERIAL STORES 2
HARDWARE STORES 2
SECURITY OFFICER 1
SECURITY SECTION 22
HANGAR CLEANING CREW 10
SANITARY CREW 4
HEAD CARPENTER 1
CARPENTRY 5
SENIOR SUPERVISOR 1
MANDALAY ENGINEERING 2
Total 31
Total 346

* Three 8-hour Shifts

** Two 8-hour Shifts

Pilots are paid a bonus for all flying over 60 hours per month. At present, pilots are averaging 120 hours or more each month. An excerpt from the Pacific-Alaska Operations Manual of Pan-American Airlines, covering basic flight-time limitations for pilots and flight engineers is included for information. The Manual is based on CAA Regulations which should be used as a standard for comparison with UBA Regulations.

EXTRACTS FROM PAA OPERATIONS MANUAL

FLIGHT-TIME LIMITATIONS FOR PILOTS AND FLIGHT ENGINEERS

1. *CAR* 41.54 *Aircraft having a Crew of One or Two Pilots*

A. A pilot may be scheduled to fly eight hours or less during any 24 consecutive hours without a rest period during such eight hours. If a pilot is scheduled to fly in excess of eight hours during any 24 consecutive hours, he shall be given an intervening rest period at or before the termination of eight scheduled hours of flight duty. Such rest period must equal at least twice the number of hours flown since the last preceding rest period and in no case will such rest period be less than eight hours. During such rest period, the pilot must be relieved of all duty with the air carrier.

B. When a pilot has flown in excess of eight hours during any 24 consecutive hours, he must receive at least 18 hours of rest before being assigned any duty with the air carrier.

C. A pilot shall not fly in excess of 32 hours during any seven consecutive days. Relief from all duty for not less than 24 consecutive hours must be provided for and given to a pilot at least once during any seven consecutive days.

D. A pilot shall not fly as a member of the crew more than 100 hours during any one month.

E. A pilot shall not fly as a member of the crew more than 1,000 hours in any 12-month period.

2. *CAR* 41.55 *Aircraft having Two Pilots and One Additional Flight Crew Member*

A. A pilot may not be scheduled to fly a total of more than 12 hours during any 24 consecutive hours.

B. When a pilot has flown 20 hours or more during any 48 consecutive hours, or 24 hours or more during any 72 consecutive hours, he must receive at least 18 hours of rest before being assigned to any duty with the air carrier. In any case, each pilot shall be relieved from all duty for not less than 24 consecutive hours during any seven consecutive days.

C. A pilot shall not fly as a member of the flight crew more than 120 hours in any 30 consecutive days or 300 hours in any 90 consecutive days.

D. A pilot shall not fly as a member of the flight crew more than 1,000 hours in any 12-month period.

3. *CAR* 41.56 *Aircraft Having Three or More Pilots and an Additional Flight Crew Member*

A. Flight hours shall be scheduled in such a manner as to provide for adequate rest periods on the ground while the pilot is away from his base. Adequate sleeping quarters on the aircraft must be provided in all cases where a pilot is scheduled to fly more than 12 hours during any 24 consecutive hours.

B. A pilot, upon return to his base from any flight or series of flights, shall receive a rest period of not less than twice the total number of hours flown since the last rest period at his base and during such period will not be required to perform any duty for the company. When the required rest period exceeds seven days, that portion of the rest period in excess of seven days may be given at any time before the pilot is again scheduled for flight duty on any route.

C. A pilot shall not fly as a member of the flight crew more than 350 hours in any 90 consecutive days.

D. A pilot shall not fly as a member of the flight crew more than 1,000 hours in any 12-month period.

4. *CAR* 41.76 *Flight-time Limitations—Flight Engineers*

When one flight engineer is required, flight-time limitations of 41.55 apply. When two or more flight engineers are required, flight-time limitations of 41.56 apply.

The UBA has a training program and recruits nationals to meet its requirements for new pilots. The students attend flying schools in England, transportation and pay being provided by UBA. Twelve students have returned and are serving their pilots' apprenticeship (2,500 hours) as co-pilots.

Consideration is being given by the UBA to sending another 12 students to UK for pilot training, as none are now in training. The training period of three years is to be reduced to one year as the students taking the 3-year training course received only one hundred and fifty flying hours. The Ministry of Education selects the trainees by rigid methods and all students who were previously sent for training completed the course. The training of radio operators is discussed in paragraph G–3–e of this chapter.

Bad feeling exists because of the differences in wages of the nationals and non-nationals who have service contracts. In consideration of the fact that pilots, co-pilots and radio operators' prospective years of service are limited by the natural and unavoidable changes in the tension to which they are subject, a higher premium should be placed on their services. A retirement program should also be developed.

(2) *The Maintenance Department* presently has a staff of 378, headed by the Superintending Engineer. In this department, training is given as a routine matter along with work performed. When the apprentice has acquired skill, he is upgraded and given a license.

Burma having orginally no trained aircraft maintenance mechanics and supervisors, UBA was forced to recruit non-nationals on service contracts. These men will be replaced as trained nationals acquire the necessary experience and skill. The Maintenance Department not only handles maintenance of the aircraft, but also maintains the buses, trucks, suburbans and cars of the Transportation Department together with its own flight crew, hangar and automotive vehicles. The four new Bedford coaches are maintained and serviced by an outside contractor, but this is extremely expensive and it should be stopped.

It is estimated that approximately a 20% increase in total staff is required to return the planes and other vehicles to service promptly. Any increase in the number of planes and vehicles will require a further proportionate increase in maintenance personnel.

(*d*) *The Traffic and Transportation Department and Accounting and Statistical Department* are staffed entirely with nationals (see Tables XVII–8 and XVII–9). The Traffic Department has further curtailed its operations by contracting the booking and freight handling at 26 terminal airports and at four foreign airports to agents at an average rate of 7% of the passenger and freight bookings out of these airports. At the domestic airports of Burma it has been noted that inexperienced labor is used by the agents in unloading and loading freight and frequently the pilot and stewards of the aircraft are forced to assist this inexperienced labor. While on the ground, the flying crew would ordinarily expect to be relieved of any duties and should be free to walk about and relax. These conditions should be corrected.

(*e*) Table XVII–10 shows the organization for the Office of the Director of Civil Aviation. As indicated, the positions of senior Flying Control Officer and Supervising Engineer are vacant, the Deputy Director presently performing the duties of these offices. The officers under the Deputy Director do not have assistants qualified to understudy them. For example, the Chief Aerodrome Officer, in addition to his other duties, is responsible for the implementation of the airport development program, described in paragraph I of this chapter. It is beyond the capabilities of one man unassisted to supervise construction at over 30 airports that will cost as much as 800 lakhs of kyats over a four-year period. The Office of the DCA has a program for expansion of its organization but is holding it in abeyance.

Table XVII–10 does not include the Aerodrome Officers and radio crews at the airports. The Aerodrome Officers are responsible for management and maintenance at the airfields, but need instruction and assistance. On the inspection flight to Papun on February 20, 1953, the pilot came in for a landing twice, only to have to overfly cattle on the landing strip. At Akyab the Aerodrome Officer employs two

TABLE XVII – 8

UNION OF BURMA AIRWAYS
TRAFFIC AND TRANSPORTATION DEPARTMENT

Manager—Commercial	1
Chief Traffic Officer	1

Rangoon
Transportation Section

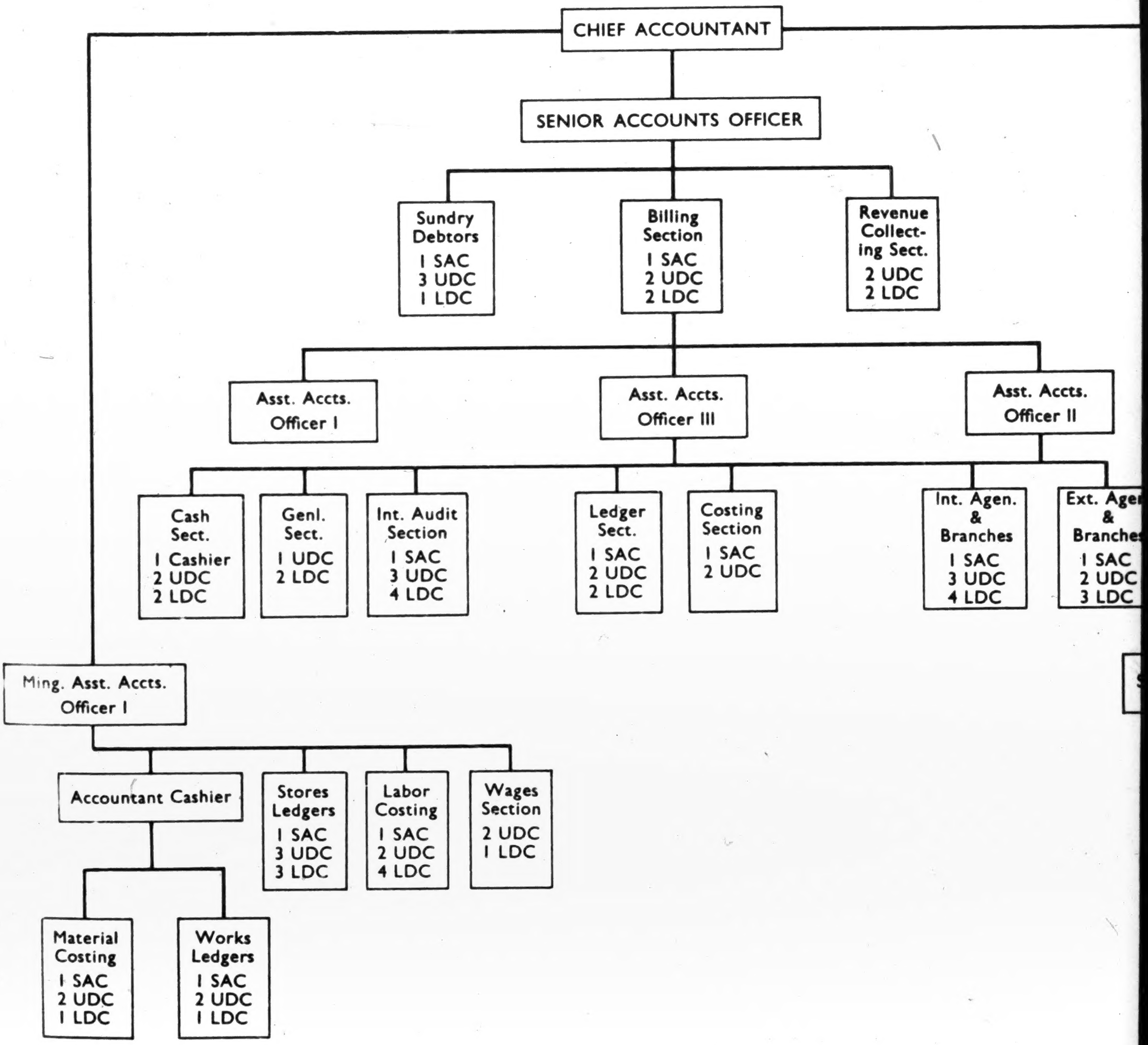
Movements Officer	1	Traffic Officer—Agent	1	Traffic Officer—Freight	1	Traffic Officer—External	1
,, Assistants	4	Traffic Officer—OSD	1	In-freight	2	Passage Bookings	2
Upper Division Clerk	1	Traffic Officer—Claims	1	Out-freight	5	Freight Bookings	2
Lower ,, ,,	1			Acceptances	1	Passenger Handling	5
Drivers	43			Newspapers	4		
Cleaners	7			Freight Shed	2		

Traffic Officer—External Handling	1	Traffic Superintendent	1	Traffic Officer	1
Booking Cashier	1	Airport Assistants	4	,, ,,	1
External Baggage	—	Traffic Handling	5	Sr. Traffic Assistant	1
Sales Girls	5	Traffic Handling	10	Jr. ,, ,,	1
Airport Cashiers	2	Flight Duties	7	Traffic Clerk	1
Sales Statements	1			,, ,,	1
Refunds	1				
General Assistant	1			Mandalay	10
				Akyab	3
				Bassein	2
				Lanywa	1
				Sandoway	1
				Thayetmyo	1

TABLE XVII-9

UNION OF BURMA AIRWAYS

ACCOUNTING AND STATISTICAL DEPARTMENT


CHIEF ACCOUNTANT
SENIOR ACCOUNTS OFFICER
Sundry Debtors
1 SAC
3 UDC
1 LDC
Billing Section
1 SAC
2 UDC
2 LDC
Revenue Collecting Sect.
2 UDC
2 LDC
Asst. Accts. Officer I
Asst. Accts. Officer III
Asst. Accts. Officer II
Cash Sect.
1 Cashier
2 UDC
2 LDC
Genl. Sect.
1 UDC
2 LDC
Int. Audit Section
1 SAC
3 UDC
4 LDC
Ledger Sect.
1 SAC
2 UDC
2 LDC
Costing Section
1 SAC
2 UDC
Int. Agen. & Branches
1 SAC
3 UDC
4 LDC
Ext. Age
&
Branche
1 SAC
2 UDC
3 LDC
Ming. Asst. Accts. Officer I
Accountant Cashier
Stores Ledgers
1 SAC
3 UDC
3 LDC
Labor Costing
1 SAC
2 UDC
4 LDC
Wages Section
2 UDC
1 LDC
Material Costing
1 SAC
2 UDC
1 LDC
Works Ledgers
1 SAC
2 UDC
1 LDC

Note: SAC = Senior Accounts Clerk
UDC = Upper Division Clerk
LDC = Lower Division Clerk

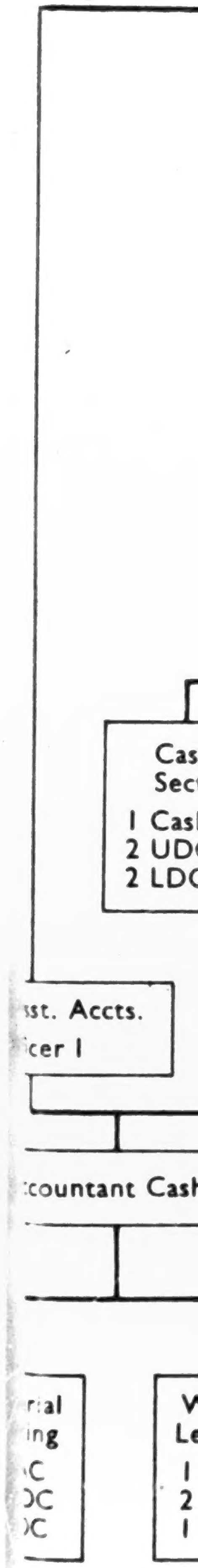

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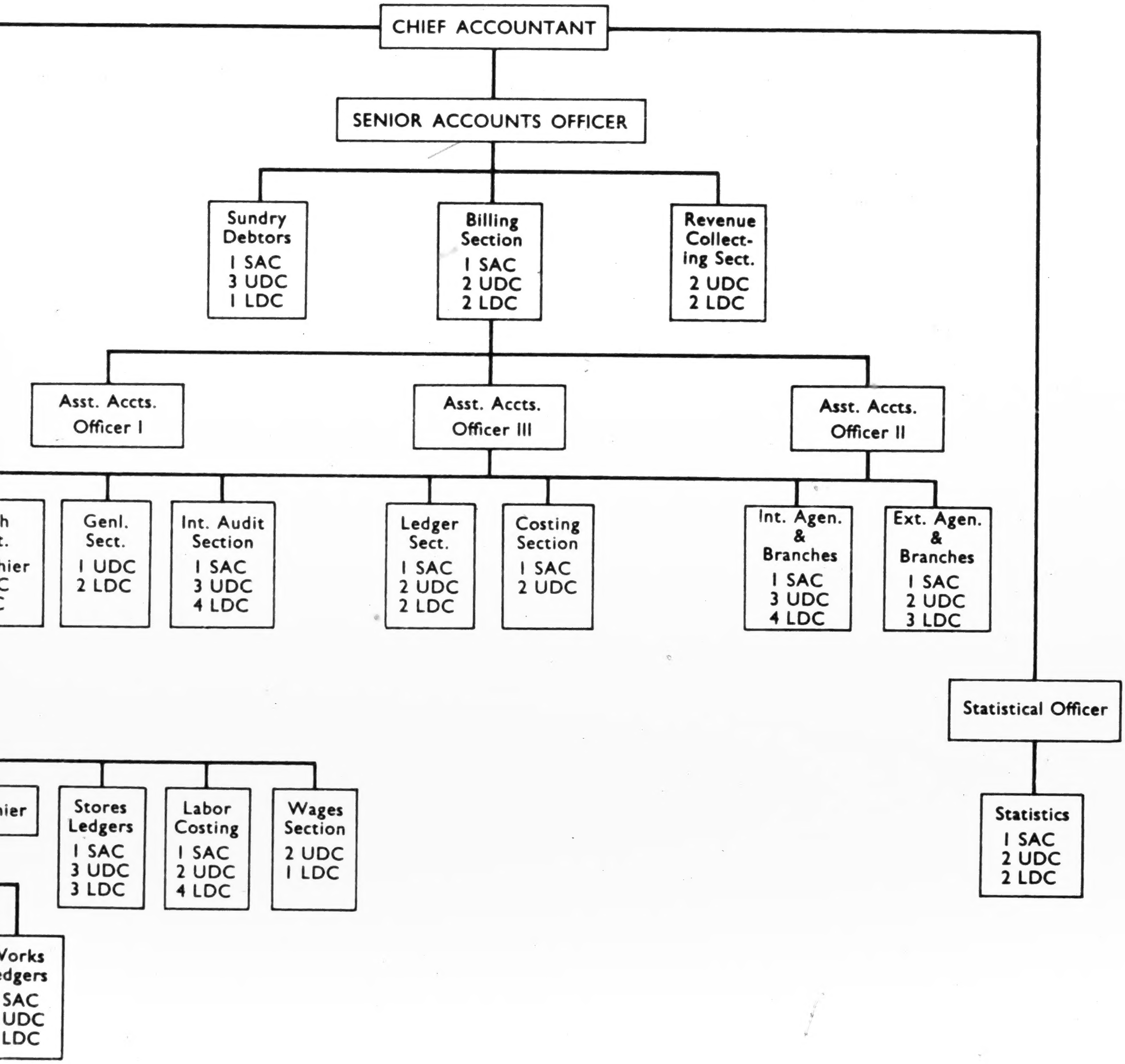
TABLE XVII-9

UNION OF BURMA AIRWAYS

ACCOUNTING AND STATISTICAL DEPARTMENT


CHIEF ACCOUNTANT
SENIOR ACCOUNTS OFFICER
Sundry Debtors
1 SAC
3 UDC
1 LDC
Billing Section
1 SAC
2 UDC
2 LDC
Revenue Collecting Sect.
2 UDC
2 LDC
Asst. Accts. Officer I
Asst. Accts. Officer III
Asst. Accts. Officer II
h
t.
hier
C
C
Genl. Sect.
1 UDC
2 LDC
Int. Audit Section
1 SAC
3 UDC
4 LDC
Ledger Sect.
1 SAC
2 UDC
2 LDC
Costing Section
1 SAC
2 UDC
Int. Agen. & Branches
1 SAC
3 UDC
4 LDC
Ext. Agen. & Branches
1 SAC
2 UDC
3 LDC
Statistical Officer
ier
Stores Ledgers
1 SAC
3 UDC
3 LDC
Labor Costing
1 SAC
2 UDC
4 LDC
Wages Section
2 UDC
1 LDC
Statistics
1 SAC
2 UDC
2 LDC
Vorks
edgers
SAC
UDC
LDC

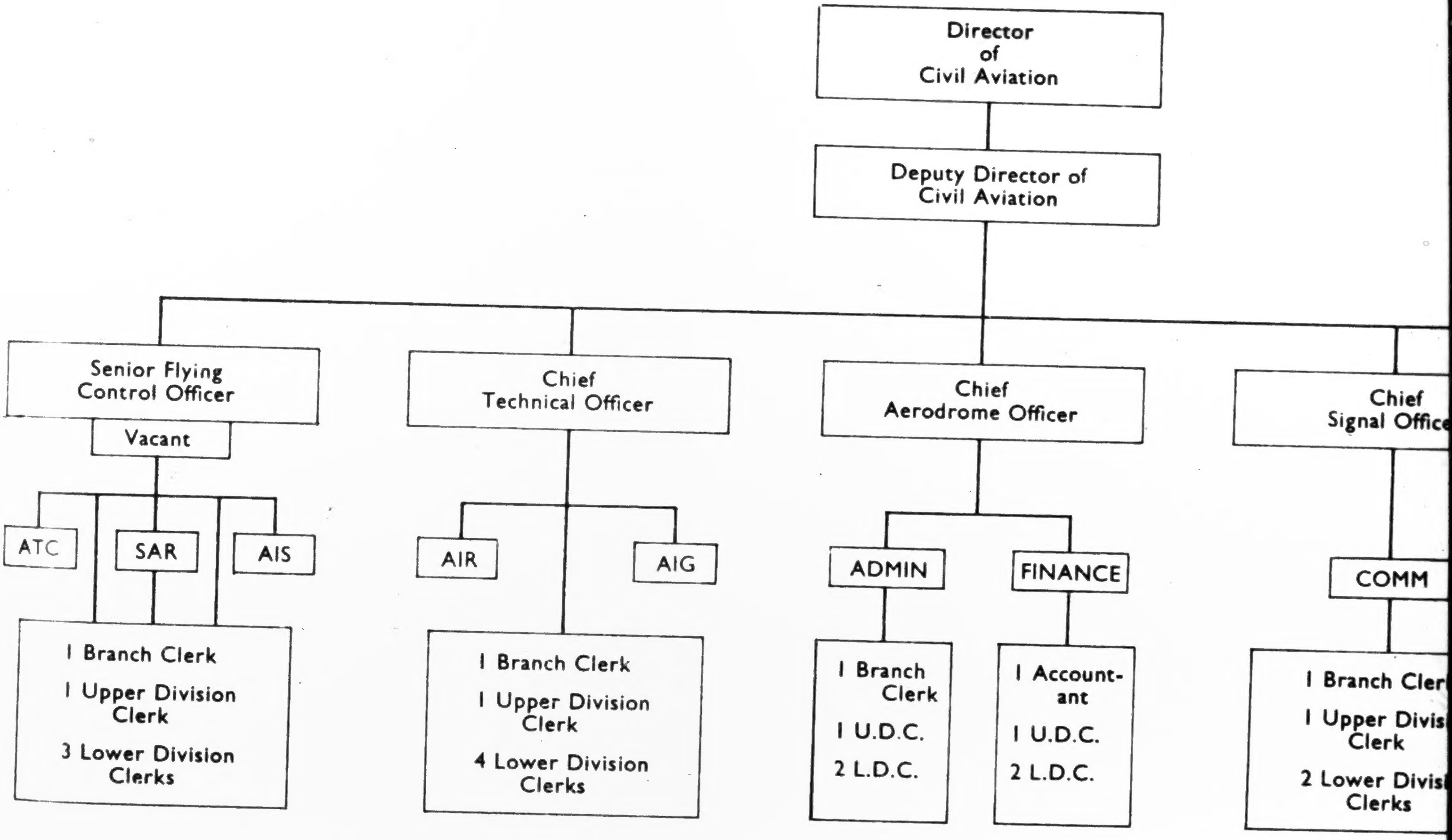
Note: SAC = Senior Accounts Clerk
UDC = Upper Division Clerk
LDC = Lower Division Clerk

TABLE XVII-10

GOVERNMENT OF THE UNION OF BURMA

CIVIL AVIATION DEPARTMENT

OFFICE OF THE DIRECTOR OF CIVIL AVIATION


Director of Civil Aviation
Deputy Director of Civil Aviation
Senior Flying Control Officer
Vacant
ATC
SAR
AIS
1 Branch Clerk
1 Upper Division Clerk
3 Lower Division Clerks
Chief Technical Officer
AIR
AIG
1 Branch Clerk
1 Upper Division Clerk
4 Lower Division Clerks
Chief Aerodrome Officer
ADMIN
FINANCE
1 Branch Clerk
1 U.D.C.
2 L.D.C.
1 Accountant
1 U.D.C.
2 L.D.C.
Chief Signal Office
COMM
1 Branch Cler
1 Upper Divisi Clerk
2 Lower Divisi Clerks

LEGEND

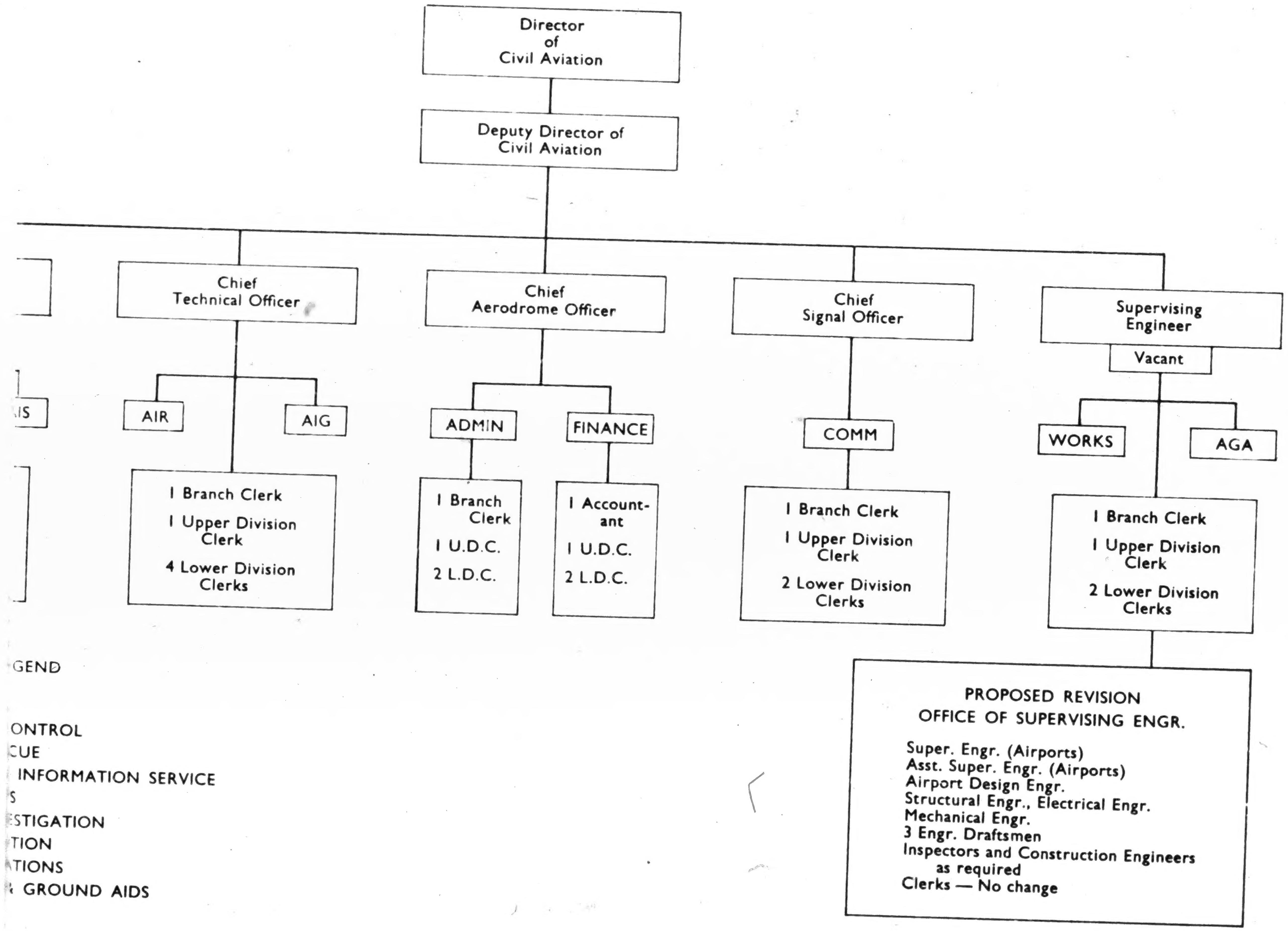
ATC = AIR TRAFFIC CONTROL
SAR = SEARCH & RESCUE
AIS = AERONAUTICAL INFORMATION SERVICE
AIR = AIRWORTHINESS
AIG = ACCIDENT INVESTIGATION
ADMIN = ADMINISTRATION
COMM = COMMUNICATIONS
AGA = AERODROME & GROUND AIDS

TABLE XVII-10

GOVERNMENT OF THE UNION OF BURMA

CIVIL AVIATION DEPARTMENT

OFFICE OF THE DIRECTOR OF CIVIL AVIATION


Director of Civil Aviation
Deputy Director of Civil Aviation
Chief Technical Officer
Chief Aerodrome Officer
Chief Signal Officer
Supervising Engineer
Vacant
IS
AIR
AIG
ADMIN
FINANCE
COMM
WORKS
AGA
1 Branch Clerk
1 Upper Division Clerk
4 Lower Division Clerks
1 Branch Clerk
1 U.D.C.
2 L.D.C.
1 Accountant
1 U.D.C.
2 L.D.C.
1 Branch Clerk
1 Upper Division Clerk
2 Lower Division Clerks
1 Branch Clerk
1 Upper Division Clerk
2 Lower Division Clerks
GEND
ONTROL
CUE
INFORMATION SERVICE
S
STIGATION
TION
TIONS
GROUND AIDS

PROPOSED REVISION
OFFICE OF SUPERVISING ENGR.

Super. Engr. (Airports)
Asst. Super. Engr. (Airports)
Airport Design Engr.
Structural Engr., Electrical Engr.
Mechanical Engr.
3 Engr. Draftsmen
Inspectors and Construction Engineers as required
Clerks — No change

laborers by the year to keep cattle off the paved runway and 30 laborers to cut the grass. A tractor-drawn mowing machine, which would amortize its initial cost in the first year of operation, could replace the 30 men. A five-strand barbed-wire fence or a single-strand electrified fence could keep the cattle off the field. The maintenance crew could be cut to three whose duties would be to operate and maintain the tractor and keep the fence in repair.

2. RECOMMENDATIONS

(*a*) The number of pilots, co-pilots and radio operators should be increased to 24. This will permit adequate rotation of the crew in the operation of the present fleet of 16 planes and reduce the probability of accidents due to crew fatigue.

(*b*) The pilot-training program should be placed on a continuing basis.

(*c*) Foreign crew members should be replaced as soon as the training program permits.

(*d*) A retirement program, financed by GUB, should be initiated at once for all UBA employees, particularly crew members.

(*e*) The personnel of the Maintenance Department should be augmented as recommended by the Superintending Engineer. The increase in personnel for the present work load should not be more than about 75 employees (20%).

(*f*) The agents who have contracted to handle booking and freight should be required to use experienced labor in handling freight.

(*g*) In DCA, the positions of Senior Flying Officer and Supervising Engineer should be filled by qualified individuals. The Supervising Engineer should be assisted by an engineering section capable of preparing plans and specifications for and supervising the construction and heavy maintenance of airfields.

The Office of the Supervising Engineer should be charged with all construction and improvements to airfields and with the preparation of estimates and reports. Five engineers and three engineering draftsmen should be provided in addition to the Supervising Engineer. One of the engineers should be from the civil field, experienced primarily in airfield pavements, airfield drainage and the application of soil mechanics to airfield pavement design. One should be a structural engineer familiar with airfield structures. Another should be an electrical engineer experienced in airfield lighting, navigation aids and power supply for the various maintenance shops and mobile equipment at the airfield. The fourth should be a mechanical engineer experienced in all phases of air conditioning, heating and ventilating as applied to airport construction. The Assistant Supervising Engineer should be a civil engineer, understudy to the Supervising Engineer. All should be qualified for temporary assignment to the field on supervision of construction.

(*h*) The Aerodrome Officers employed at the various airports should be engineering graduates and should receive training under both the Chief Aerodrome Officer and the Supervising Engineer prior to appointment.

E. AIR SAFETY, AIRCRAFT AND WORKSHOP

1. AIR SAFETY

a. Safety Record

UBA has a notable air safety record for the four and one half years since its formation. It is estimated that in excess of 120 million passenger miles have been flown, with a total of 11 fatalities, or 11 million passenger miles per individual fatality.

One Dove aircraft was lost to insurgents, one burned off its gas as it skidded on a collapsed landing gear. In neither of these accidents were lives lost. One Dakota aircraft, upon attempting to land at Mergui, was dropped by a cool thermal, had a wing sheared by tree tops in the approach zone, and spun in on the overshot zone outside the threshold of the airstrip. The passengers and crew left the plane safely before a slow fire burned out this aircraft. The cause of the loss of the de Havilland Dove aircraft XY–ABO on March 14, 1949, could not be determined by the Board of Inquiry. This aircraft was seen from shore to fall and sink in the Gulf of Martaban offshore from the mouth of Myitkyina Creek. Nine passengers and two crewmen are presumed to have been drowned, and there were no survivors. As no airport radio installation was then at Moulmein it was only the failure of the aircraft to return to Rangoon which inspired search efforts. The Board of Enquiry recommended "radio facilities be installed at all stopping places for internal service."

b. Safe Operating Procedures

In order that the record of safety be maintained, the UBA exercises vigilance in every phase of operations. The Superintending Engineer, the Chief Pilot, the Chief Signals Officer, and the Duty Officer, who changes daily and is normally a co-pilot, all have certain requirements prerequisite to a scheduled or non-scheduled flight before any aircraft is given departure clearance.

(1) Continuing Airworthiness of Aircraft

Certificates for continuing airworthiness of aircraft are renewed periodically at intervals not exceeding 12 months and cover a complete overhaul including: removal of all components of the aircraft even to the entire removal of all paint upon the airframe to check for cracks or fissures; overhaul of propellers with appropriate tests; overhaul of the fuel system, testing for flow rates, vapor lock, fuel-feed system arrangement, tank strength, construction and installation, and checking fuel indicators, flowmeters, fittings, valves and accessories, and fuel-jettisoning systems; testing the oil systems, cooling power plant instruments and controls, exhaust systems, induction systems, firewalls and cowling, and fire protection. All tests are made under the supervision of properly qualified certificated mechanics.

(2) Operations of Aircraft

Conformance with recommendations of ICAO is generally attempted by UBA, which is a primary reason for the continuing record of safety of the airline. Exact records are kept of all aircraft conditions during flight, and the flight plans are prepared to avoid conflict with advice of Air Traffic Control, the Meteorological Bureau, and Communication Service. Weight limitations are carefully followed as to crew, fuel, passengers, baggage and freight. The conditions of the airstrips limiting weights are also watched for safe landing-load. All aircraft in UBA are provided with an operation manual, a maintenance manual, a maintenance release and a journey log-book. Non-compliance, however, was noted to the requirement that before a pilot acts as pilot-in-command on a route he has never flown he shall be certified for the route by a pilot who has previously proven his knowledge of the route. The importance of adherence with this recommendation cannot be overstressed.

2. AIRCRAFT

a. Observations

Service is inadequate especially for the transportation of perishable freight. UBA is unable to accept charters at all times; to provide search at all times; or to spare planes from the line for minor repairs or major overhaul. Necessity for minor repairs to planes grounded elsewhere than at Mingaladon frequently finds UBA without a plane in reserve to take the needed mechanics and parts to the airport. Curtailment of schedules and the consequent loss of revenue would result should several of the Dakotas, the work-horses of the fleet, be in the shops at the same time. To serve the numerous small airfields in the vicinity of Mandalay which are substandard for Dakotas, a shuttle service based at Mandalay and equipped with the lighter-weight Doves should be instituted.

The service performance of the Dakotas has been so excellent for so long it is difficult to recommend any change other than that more consideration be given to the use of the lighter Doves on the numerous short hauls and low income producing routes. The low fuel consumption of the Dove on short flights up to 45 minutes permits it to complete such a flight on an amount of fuel equivalent to that used by the Dakota for taxiing and warm-up prior to departure. The comparison of operational aircraft given in Tables XVII-11, 12 and 13, illustrates these character-

Table XVII – 11

AIRCRAFT WEIGHT ANALYSIS

	Dove I	*Dakota III*
	(all weights in lbs.)	
1. Structure weight	2,390	8,830
2. Power plant and systems weight	2,160	5,620
3. Operating equipment weight	830	2,340
4. Passenger equipment weight	440	1,740
5. Empty weight	5,820	18,530
6. Cockpit crew	400	600
7. Cabin crew	—	200
8. Fixed stores	—	250
9. Unusable fuel	50	170
10. Basic weight	6,270	19,750
11. Maximum oil capacity	130	430
12. Equipped weight	6,500	20,180
13. Maximum usable fuel capacity	1,160	4,750
14. Corresponding payload	940	3,120
15. Usable fuel with capacity payload	—	—
16. Capacity payload	2,100	7,870
17. Disposable load	2,100	7,870
18. Gross weight	8,500	28,050
19. Preflight fuel allowances	7	50
20. Maximum take-off weight	8,500	28,000
21. Maximum landing weight	8,500	26,000

Table XVII – 12

BASIC PERFORMANCE DATA

	Units	*Dove I*	*Dakota III*
1. Total take-off power	e.p.h.	690	2,400
2. Meto-power	e.p.h.	570	2,100
3. Cruise power assumed (mean)	e.p.h.	414	1,050
4. Per cent of meto-power assumed for cruise	per cent	71·5	72·5
5. Cruising height at start of flight regime	ft.	8,000	8,000
6. Cruising height at end of flight regime	ft.	8,000	8,000
7. Assumed average cruising fuel consumption	lb. hr.	194	470
8. Assumed specific cruising fuel consumption	lb. e.p.h. hr.	0·469	0·448
9. Cruising speed at take-off weight	m.p.h.	179	166
10. Cruising speed at 85% take-off weight	m.p.h.	183	174
11. Cruising speed at 70% take-off weight	m.p.h.	187	178
12. Cruising consumption at 85% take-off weight	lb. miles	1·06	2·70
13. Air miles per gallon	a.m.p.g.	6·64	2·55
14. Theoretical still-air range at operating height (no allowances)	stat. miles	1,095	1,760
15. Estimated take-off distance to reach 50 ft. on full power at max. take-off weight	ft.	2,370	3,540

TABLE XVII – 13

AIRCRAFT OPERATIONAL ANALYSIS

Tabulated Summary of "Hour Charts"

	Dove I	*Dakota III*
1. Cruising height	8,000 ft.	8,000 ft.
2. Capacity payload	2,100 lbs.	7,870 lbs.
3. Total fuel reserves (diversion and stand-off)	333 lbs.	1,535 lbs.
4. Flight time on reserves	1·65 hrs.	3·20 hrs.
5. Distance covered in climb and descent in still air	44 miles	97 miles
6. Shortest stage block speed, still air	66 m.p.h.	97 m.p.h.
7. Payload for shortest stage	1,633 lbs.	4,277 lbs.
8. Time on shortest stage (allowances)	0·66 hrs.	1·00 hrs.
9. Max. stage distance covered with payload for shortest stage in still air	44 miles	570 miles
10. Block speed	66 m.p.h.	145 m.p.h.
11. Payload for max. stage length	940 lbs.	3,120 lbs.
12. Max. stage length no wind	650 miles	970 miles
13. Block speed	158 m.p.h.	154 m.p.h.
14. Max. stage length 30 m.p.h. headwinds	550 miles	780 miles
15. Block speed	132 m.p.h.	126 m.p.h.
16. Max. stage length 60 m.p.h. headwinds	435 miles	620 miles
17. Block speed	104 m.p.h.	99 m.p.h.
18. Max. stage length 90 m.p.h. headwinds	not computed	
19. Block speed	"	"

		A.U.W. *(lbs.)*
DOVE I	de Havilland DH104 (two 320 b.h.p. DH Gypsy Queen 70)	8,500
DAKOTA III	Douglas DC-3c (two 1,200-b.h.p. Pratt & Whitney Twin Wasp R-1830.92)	28,000

istics. The Burma Airways chart and the UBA records of freight and passengers handled on these short routes further support the adoption of a shuttle operation.

The weight of freight continuously handled to and from Rangoon and Mandalay would seem to warrant a daily freight service and by a plane better suited to receive and discharge freight than is the Dakota. Passenger comfort is given second consideration after freight, and the UBA traffic department has been found to almost extend itself to placing freight in the laps of the passengers. It is packed under the seats, in the space between provided for feet, and frequently down the aisles. The last is considered a hazard to the rapid discharge of passengers, if need arises, and is prohibited by law on most common carriers.

c. Recommendations

It is recommended that:

(1) Further study be made of the prospective passenger-traffic loads and that the passenger fleet be increased to accommodate these loads.

(2) A shuttle service be initiated between Mandalay and all airports lying north of Lanywa and Heho. The Dove aircraft should be used for this service.

(3) Daily freight service be instituted between Rangoon and Mandalay, utilizing C–47 cargo planes. The basic weight of the C–47 cargo plane is 18,000 lbs., maximum gas and oil weight is 5,284 lbs. and the recommended gross weight is 29,000 lbs. The recommended gross weight of 29,000 lbs. is within the allowable load of 30,000 lbs. for the existing airstrips. This service will add to the comfort of passengers flying with the passenger planes by relieving them of freight, and can be increased as the demand indicates.

3. WORKSHOP

Airworthiness of aircraft is dependent on the adequacy of equipment and efficiency of personnel in the maintenance and overhaul workshops. These should be stocked with every needed spare part in sufficient quantities to insure availability, and should be staffed with well-supervised, well-trained repair crews.

The recommendations of the Preliminary Report are being carried out. Until recently, the entire workshop facilities of UBA were crowded into one hangar at Mingaladon where all repairs are concentrated. The Burma Air Force, however, has turned over a second hangar to UBA, and motor assembly and checks are made in it. UBA has authorized its Superintending Engineer to end the present congestion and as a consequence inflammable materials, such as paints and remover solvents have been moved into a temporary building while a new shed is under construction. Major engine overhaul is to be moved entirely from the hangars into its own building, and the necessary line is to be tooled. A spare-parts shed is now being equipped with tagged bins for which check-in, check-out and tally cards are being cross-indexed between receiving, stock and requisition departments. A separate propeller-test area is planned. The shops are also equipped to overhaul and test radio equipment, to completely rebuild and service batteries, and to quickly remove and install aircraft engines. It is in need of machine tools and a full line of hand tools. It is in need of an entire assortment of vital spare parts now almost out of stock in the UK and available in the United States only with dollars. It is estimated that an allotment of $100,000 is required over the next several years to care for this spare stock parts need.

Mechanics are trained in the shops and the Maintenance Division closely inspects and checks all work performed. On various field trips to the shops it has been found that work is continuously in progress with no indication of idleness.

F. AIRPORTS, FACILITIES AND TERMINALS

Air inspection was made during December 1952 and February 1953 of 27 of the airports. Table XVII–14, indicates the actual conditions found. Only during the dry season of the year can UBA operate aircraft to all 33 airports, as only seven of the airports are usable in all-weather conditions. Plate 3 is a sample inspection form for an airport, based on ICAO standards, for the heaviest class of aircraft presently in use in Burma. No further comment upon the poor conditions of the actual airstrips is necessary than to state that on ICAO standards most of Burma's airfields would be condemned for commercial traffic. A digest of ICAO recommendations is to be found at the end of this chapter.

Paragraph I, Future Developments, presents the program of the office of the DCA. This program places greater emphasis on extending the system than on improvement of the various airports now served. The excellence of the safety record of UBA cannot be attributed to the character of the airports, but must be a reflection of the ability of the pilots, coupled with careful maintenance. Some of the existing airports have been programmed for improvement, but the program is phased over too long a period and does not include all of the needed work at airstrips. The conditions of the approach and departure zones, the use of rocks to define the edge of the paved strips, the narrowness of the paved and usable strips, the obstructions found in the latter, the orientation of certain of the strips, and the lack of transverse drainage all require expeditious correction. The sample inspection check sheet (Plate 3) together with the digest of ICAO recommendations should constitute the minimum in design.

Few of the airports have terminal buildings and facilities. However, the development program of the DCA includes these features at certain of the airports. The development program should encompass the entire system. As stated elsewhere, the traffic and transportation division of UBA contracts these services to private individuals at most of the airports for a commission of 7% of the passenger and freight booking originating at these airports.

The transportation fleet at Rangoon has in the previous year acquired three new Bedford coaches, and has a sizable fleet of buses and freight trucks to handle passenger and freight traffic between its central booking office on Strand Road and Mingaladon. Other than this, the transportation service between the airports and town terminals of the rest of the system is of such poor quality as to be out of keeping with the services generally expected in connection with air travel. At certain of the inland airports and seaports a high-bodied truck offers the only means of transportation, the floor being the only seating provided, and a stool the means of access. The passenger handles his own baggage. Such a condition leaves unlimited room for improvement at little cost. The town terminal building is a symbol and advertisement of the airways system. These also could be improved at little cost.

Digest of *Recommended and Standard Practices* for Engineering Design of Aerodromes—*International Civil Aviation Organization*—Annex 14—Adopted May 29, 1951; Effective November 1, 1951.

The above authority recommends that design of airstrips shall be fitted to the character of the traffic expected. The Union of Burma Airways is presently using aircraft with single wheel-loads of approximately 15,000 lb., and consequently the design required by the above authority places the airstrip in the class Code number 6 and the related Code letter F, which shows a required basic length minimum of 3,500 ft. and maximum of 4,200 ft., which lengths are for airstrips constructed at mean sea level, temperature 59° F., pressure 29·92126 inches (1013·25 millibars) of mercury.

The recommendations for an increase in length from the minimum are as follows and are based on standard American practices.

Altitude Correction—Basic length to be increased by 7 of elevation above mean sea level.

Temperature Correction—Altitude corrected length to be further increased by 0·50% for each degree Fahrenheit which the temperature of the hottest month exceeds the standard temperature of the site.

Longitudinal Slope—The runway length be further increased to correct for runway gradient at the rate of 20% of the length corrected for density altitude for each 1% of effective runway gradient. The effective runway gradient is determined by dividing the maximum difference in runway center-line elevation by the total length of the runway.

Runway Alignment—The number of runways at an aerodrome and their orientation should be such that for as large a percentage of time as practicable but for not less than 95% there is at least one runway for which the surface wind velocity component at right angles to its longitudinal axis will not prevent the landing or taking off of aircraft that the aerodrome is intended to serve. The competent authority on design may, however, after taking into consideration the fact that aircraft designs are becoming less critical with respect to wind conditions, decide that the aerodrome is intended to serve those classes of aircraft that are capable of being operated under moderately high cross-wind conditions.

Longitudinal Slopes—It is further recommended that for code F airstrips the slope of a straight line joining the center points of the extremities of a runway should not exceed 1% and along no portion of the runway should the slope exceed 1·5%. Where slope changes cannot be avoided the transition from one slope to another should be ac-

TABLE XVII – 14

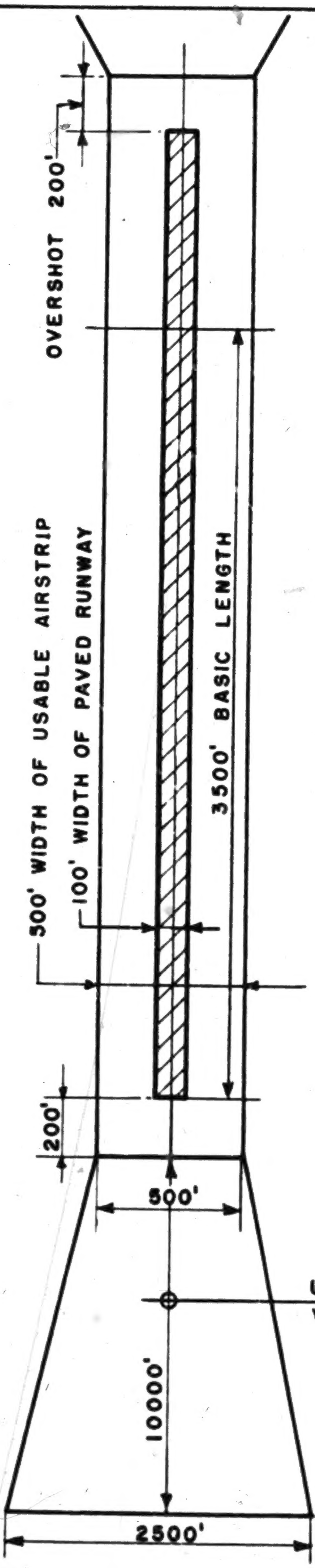
AERODROMES—INSPECTION REPORT

No.	Item	No.	*Akyab*	*Anisakan*	*Bassein*	*Bhamo*	*Gangaw*	*Heho*	*Henzada*	*Kalemyo*	*Keng Tung*	*Kyaukpyu*	*Kyauktu*	*Lanywa*	*Lashio*	*Loikaw*	*Magwe*	*Mandalay*	*Myaungmya*	*Meiktila*	*Mergui*	*Mingaladon*	*Momeik*	*Monywa*	*Moulmein*	*Myitkyina*	*Pakokku*	*Pauk*	*Putao*	*Sandoway*	*Shwebo*	*Singaling Khamti*	*Tavoy*	*Thaton*
1.	Sight-distance is full length of airstrip	1	Y	Y	Y	Y	Y	Y	A NEW AERODROME IS UNDER CONSTRUCTION HERE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	NOT INSPECTED	Y	N	Y	Y	Y	NOT INSPECTED	Y	NOT INSPECTED	Y	Y	NOT INSPECTED
2.	Alignment is oriented with the wind	2	N	N	N	N		Y		N		N		Y	Y	Y	Y	Y	N	Y	N	N		Y	N	Y							N	
3.	Longitudinal Profile	3	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y		Y		Y	Y	
4.	Transverse Profile is full width and drains	4	N	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	Y		N	Y	N	N	N		N		N	N	
5.	Drainage of airstrip is natural and good	5	N	N	N	N	N	Y		N	N	N	N	Y	N	N	N	Y	N	Y	N	Y		N	N	Y	N	N		N		N	N	
6.	Drainage Ditches are 250 ft. clear of centerline	6	N	N	N	N	N	N		N	N	N	N	N	N	N	N	Y	N	N	N	Y		N	N	N	N	N		N		N	N	
7.	Airstrip Paved Surface	7	N	N	N	Y	N	Y		N	*	N	*	Y	Y	N	N	Y	N	N	Y	Y		N	*	Y	N	N		N		N	N	
8.	,, ,, ,, is full 100 ft. wide	8	Y	N	N	N	N	N		N	N	Y	N	N	Y	N	N	N	N	N	N	Y		N	N	Y	N	N		N		N	N	
9.	,, ,, ,, is design length	9	Y	N	N	Y	Y	Y		N	N	Y	N	N	Y	Y	Y	N	Y	Y	Y	Y		N	Y	Y	N	Y		N		N	N	
10.	Usable width is full 500 ft.	10	N	Y	N	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	Y		N	N	Y	N	N		N		N	N	
11.	Glide Angle on Approach	11	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y		Y	Y	Y	Y	Y		Y		Y	Y	
12.	On Departure	12	Y	N	Y	Y	N	Y		N	Y	Y	N	Y	N	Y	Y	Y	Y	Y	N	Y		Y	Y	Y	Y	Y		N		N	Y	
13.	Approach Zone is clear of trees and obstructions	13	N	N	N	Y	Y	Y		Y	N	N	Y	Y	N	Y	Y	Y	Y	Y	N	Y		N	N	Y	N	Y		Y		Y	Y	
14.	Departure	14	Y	N	N	Y	Y	Y		Y	N	Y	N	N	N	Y	Y	Y	Y	Y	N	Y		N	N	N	N	Y		N		N	Y	
15.	Field is protected from trespass by cattle	15	N	N	N	N	N	N		N	N	N	N	Y	N	N	N	Y	N	N	N	Y		N	N	N	N	N		N		N	N	
16.	Overshot Zone is clear and usable	16	Y	N	N	Y	Y	Y		N	N	Y	N	N	N	Y	Y	Y	Y	Y	N	Y		Y	Y	Y	Y	Y		N		N	Y	
17.	Runway Strength in dry weather	17	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y		Y		N	Y	
18.	Aerodrome has Radio Installation	18	Y	N	Y	Y	N	Y		N	N	N	N	N	Y	N	Y	Y	N	N	Y	Y		N	Y	Y	N	N		N		N	Y	
19.	,, ,, Radio Beacon	19	Y	N	N	N	N	Y		N	N	N	N	N	N	N	N	Y	N	N	Y	Y		N	N	N	N	N		N		N	N	
20.	,, ,, Temporary Night Lights	20	Y	N	Y	N	N	Y		N	N	N	N	N	Y	N	Y	Y	N	N	Y	N		N	Y	Y	N	N		N		N	Y	
21.	,, ,, Permanent Night Lights	21	N	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	Y		N	N	N	N	N		N		N	N	
22.	,, ,, Staff Housing	22	Y	N	Y	N	N	Y		Y	N	N	N	N	Y	N	Y	Y	N	N	Y	Y		N	Y	Y	N	N		N		N	N	
23.	,, ,, Terminal Building	23	N	N	Y	N	N	Y		N	N	Y	N	N	Y	N	Y	N	N	N	N	Y		N	Y	Y	N	N		N		N	N	
24.	,, ,, Standard Wind-sock	24	N	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	N		N	N	N	N	N		N		N	N	
25.	,, ,, Threshold Markings	25	N	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	Y		N	N	N	N	N		N		N	N	
26.	,, ,, Centerline and Edge Markings	26	N	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	Y		N	N	N	N	N		N		N	N	
27.	,, ,, Runway Designation Markings	27	N	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	N		N	N	N	N	N		Y		N	N	
28.	,, ,, a needed Apron	28	Y	Y	N	Y	N	Y		Y	Y	Y	N	Y	Y	Y	N	Y	N	N	Y	Y		N	Y	Y	N	N		N		N	N	
29.	,, is usable in all weather conditions	29	N	N	N	N	N	Y		N	N	N	N	Y	Y	N	Y	Y	N	N	N	Y		N	N	Y	N	N		N		N	N	

DESIGNATIONS

N—Not Satisfactory. Y—Satisfactory. *—Work in Progress.

Note: The Office of the Director of Civil Aviation has requested sanction of the Government to construct new Aerodromes at Victoria Point, Myingyan, Toungoo, Buthidaung, Prome and Thayetmyo.


OVERSHOT 200'
500' WIDTH OF USABLE AIRSTRIP
100' WIDTH OF PAVED RUNWAY
3500' BASIC LENGTH
200'
500'
UNOBSTRUCTED APPROACH ZONES BOTH ENDS
VERT. TO HORIZ. 1:30
10000'
2500'

CLASS F AIRPORTS

SINGLE-WHEEL-LOAD OF 15,000 LBS.
PAVEMENT DESIGNED FOR STATIC LOADING OF 70 LBS. PER SQUARE INCH
MAXIMUM TRANSVERSE SLOPE 1.5%
" LONGITUDINAL " 1.5%
ON THE PAVED RUNWAY AND 2% ON THE USABLE WIDTH BEYOND
BASIC LENGTH TO BE INCREASED 7% OF THE ALTITUDE ABOVE MEAN-SEA-LEVEL
THIS NEW LENGTH TO BE CORRECTED ADDING 0.5% FOR EACH DEGREE FAHRENHEIT BETWEEN THE HOTTEST MONTH AND THE STANDARD TEMPERATURE OF THE SITE.
THE ORIENTATION TO BE SUCH THAT 95% OF THE TIME THE STRIP SHALL BE USABLE DESPITE SURFACE WIND VELOCITY.
NOTE: SEE PRINTED INSTRUCTIONS FOR OTHER DETAILS AND FACILITIES.
LIST IMPORTANT RECOMMENDATION ON THE REVERSE SIDE OF THIS REPORT SHEET.

	EXISTING	REQUIRED
LENGTH		
PAVED WIDTH		
USABLE WIDTH		
GRADES		
DRAINAGE		
TERMINAL BLDG.		
RADIO CONTROL		
EMERGENCY POWER		
EMERGENCY LIGHTING		
STAFF QUARTERS		
ORIENTATION		
SIGHT DISTANCE		
RUNWAY STRENGTH		
STRIP MARKINGS		
OVER-SHOTS		
TRANSVERSE SLOPES		
APPROACH ZONES		
WIND SOCK		
SURFACE TREATMENT		

INSPECTION CHECK SHEET
AIRPORT: ______________

MINISTRY OF NATIONAL PLANNING

INTERNATIONAL CIVIL AVIATION
ORGANIZATION STANDARDS.
1, NOVEMBER 1951.

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON

DR. BY. E.J.P. DATE
CK. BY. E.P.T. MAY 53.
PLATE NO. 3.

complished by a curved surface with a rate of change not exceeding 0·3% per 100 feet. This is equivalent to a minimum radius of curvature of 33,000 feet.

Sight Distances—Where slope changes cannot be avoided, they should be such that there will be an unobstructed line of sight from any point 10 feet above the runway to all other points 10 feet above the runway within a distance of at least half the length of the runway.

Distances Between Slope Changes—Frequent undulations or appreciable changes in slope located close together along a runway should be avoided. The distance between two successive transition curves measured from their points of intersection of the curve should be not less than the sum of the absolute numerical values of the corresponding grade changes multiplied by 25,000 feet.

Example: x the grade to the left, y the grade within the two points on intersection curves and z the grade to the right are successively plus 0·01, minus 0·005, and plus 0·005.

And 25,000 times (x minus y, plus, y minus z).

Therefore: x minus y = 0·015 and y minus z = 0·01.

Or 25,000 feet times (0·015 plus 0·01) equals 625.

Runway Strength—For code F airstrips (15,000 lbs. single wheel load) an associated tire pressure shall be assumed at 70 lbs. per square inch. This is ten lbs. greater than the DC-3 in use by the Union of Burma Airways.

Overshot Strip—Shall extend 200 ft. beyond the paved runway and have the required width, for class code F airports, of 250 ft. each side of the center line.

Transverse Slopes—Shall be such as to drain the surface but should not exceed 1·5%.

Width of Usable Strips—For runways other than instrument operated, the width should be 250 feet each side of the center line for code letter F runways. It is not intended that areas paralleling and outside the 500 ft. of usable strip be prepared in any way for landings but rather that they be cleared of hazards to aircraft.

Strength—Those portions of the usable strip immediately beyond the paved runway should be so prepared or constructed as to minimize hazards arising from the difference in load-bearing capacity, to an aircraft running off the paved runway.

Width of Paved Runway—For airstrips in the class code letter F the width should be 100 ft. Two parallel runways should be separated 500 ft. on their center lines.

Taxiways—Taxiways should be so provided as to permit the safe and expeditious handling of aerodrome traffic.

Aprons—Aprons should be provided as and when necessary for the reasons above stated.

Aerodromes—Lighting of aerodromes and marking of obstructions nearby should be provided as traffic demands.

Approach Zones—For airstrips in the class code letter F should be trapezoids with center lines the extension of the runway center lines, 500 ft. wide at the airstrip and 2,500 ft. wide at a distance of 10,000 ft. from the airstrip. The unobstructed glide path shall have a vertical-horizontal ratio of 1 : 30.

Horizontal Approaches—Have their inner edges at 13,000 ft. from the geometric center of the runway and are connected to the approach zone by transition slopes of vertical-horizontal ratio of 1 : 7.

Wind-direction Indicators—All aerodromes shall be equipped with at least one wind-sock so located as to be visible to approaching aircraft and unaffected by nearby structures. They should be not less than 12 ft. long and 3 ft. in diameter at the supported end. The color should be discernable at 1,000 ft. having regard for background. White or orange is preferable and but a single color should be used.

Signaling Lamp—Shall be provided at all aerodromes.

Emergency Lighting—Shall be provided at all aerodromes intended for use at night.

Aerodrome Identification Signs—Shall be provided where there is insufficient other means of identification. It should be the name of the aerodrome and in letters ten feet high.

Aerodrome Beacons—Shall be provided at all aerodromes intended for use at night. For land aerodromes the color shall be green and for water aerodromes yellow. It shall have a peak intensity of 2,000 candle power and emit light at all angles in azimuth and up to at least 45° above the horizontal. They shall be on or adjacent to the aerodrome and identification characters shall be transmitted in the Morse Code at a speed of between six to eight words per minute, the corresponding range of duration of the Morse dots being from 0·20 to 0·15 seconds.

Approach Day Marking System—When in the opinion of the competent authority the system is required; a single row of markers at a minimum distance of 200 ft. and a maximum of 300 ft. apart shall be provided in the middle of the runway at its approach end. They should have a surface area of a minimum of ten square ft. and not constitute obstructions.

Threshold Markings—Shall be provided at the end of the runway and shall number four across its width.

Runway Designation Markings—All runways shall be numbered with a two-digit number at each end. The number assigned shall be that whole number nearest to one tenth of the magnetic azimuth of the center-line of the runway, measured clockwise from Magnetic North when viewed from the direction of approach. Parallel runways shall be so identified by "L" and "R" for two; by "L", "C", "R", for three; and by "L", "LC", "RC", "R" for four runways.

Longitudinal Markings—Runway longitudinal markings should be displayed on all runways and should be one of several recommended designs.

Approach Lighting System—Shall be provided on all runways intended for use at night and shall comply with one of several alternate recommended designs. This applies also to runway threshold lights.

Emergency Power Supply—Shall be provided for radio and land-line communication equipment for aeronautical, mobile and fixed equipment and services and for minimum lighting necessary to enable air-traffic services personnel to carry out their duties.

G. FLIGHT CONTROL AND SIGNAL COMMUNICATION

1. FLIGHT CONTROL

There are three groups of frequencies in the v.h.f. band used for aircraft control. These are for Airfield-control, Approach-control, and Area-control. The use of these frequencies is dependent on the density of the air traffic, for if only one aircraft was in the region it would be possible to pass all instructions on one v.h.f. channel and to use the same frequency for D/F purposes. Where a number of aircraft are flying in the region of control, different frequencies are used. The division of control is then dependent on the distance of the aircraft from the controlling airfield. Airfield control is the term applied to the immediate vicinity. Approach control extends up to about 75 miles. At Mingaladon approach control applies within a radius of 115 miles and area control to the boundary of the region or the extreme range of the equipment. The International Civil Aviation organization has assigned the Government of Burma at Rangoon a region larger than Burma itself. This region is bounded by Burma land geographic boundaries and by the 92° and 100° meridian of east longitude to the 10° parallel of latitude north. Control of all aircraft is assumed upon their entry within this Region.

The present density of internal air traffic requires only two frequencies at the minor airports; i.e. airfield-control and approach-control.

(a) **Approach-control** is utilized for normal control and direction-finding facilities and its inside limit is the airfield vicinity. This means that aircraft will be in continuous contact on this frequency and that in the event of distress a series of bearings will be available for assistance to the pilot.

(b) **Airfield-control** is limited to the immediate vicinity of the airfield and is on a separate frequency so that a minimum of interference is caused to any aircraft requiring D/F assistance.

(c) **Radio beacons.** Further navigational facilities for domestic-flying aircraft are medium-powered MF beacons placed at selected airfields in order that a pilot may obtain fixes by means of the aircraft radio compass. Thus within a grid of these beacons he can plot his absolute position. These are used also for homing aircraft and facilitate landing at airstrips that are in difficult locations to approach, as at Tavoy where an adjacent mountain intrudes.

In Burma there are five radio beacons, four of which are on the coast at Akyab, Mingaladon, Tavoy and Mergui. One is at Mandalay. Because of the mountainous terrain of much of Burma, because most of the navigation is solely dependent upon visual aid during periods of high cross-winds which can carry the aircraft far off its course, and because visual navigation during these periods is often prevented by poor visibility, it is important that an internal grid of radio beacons be installed so that the aircraft position can never be lost. If aircraft radio become inoperative for reception, or if for some reason the aircraft can signal only a distress landing without being able to give its position, the VHF/DF equipment can be used to obtain azimuths of the distress signal and to furnish search and rescue information.

It is noted that the office of the DCA has budgeted requests for authorization to equip additional airports with radio. It is also noted that four years have elapsed since an accident inquiry board recommended "all airports be radio equipped," and still two thirds of Burma Airways airports are without this facility.

2. SIGNAL COMMUNICATION

(a) **Internal service R/T** is for communications between aircraft and ground stations for the purpose of passing approved messages, such as estimated arrival time, position in case of distress, number of seats available and weight of freight which can be booked. This service can be used also to inform the traffic officer at Mingaladon of any heavy traffic condition so that a non-scheduled flight can be arranged.

(b) **Radio controls and equipment** are presently provided at but 12 of the 33 airports of Burma to which service is flown. The DCA has control of all radio services at airports so equipped. A nominal charge was formerly made for each landing of aircraft at the rate of K10 for Doves and K25 for Dakotas but has been discontinued. Since January 1, 1952, the DCA has taken over control of the full operations of International Aeradio Ltd., with the exceptions of the main transmitter station at Mingaladon and operations at Mergui and Akyab. The main transmitter station at Mingaladon is to be moved to another building as the Burmese Army requires the building for its use. Repairs, adjustments and new installations of the UBA radio system are still contracted to International Aeradio Ltd. by DCA.

3. CONCLUSIONS AND RECOMMENDATIONS

(a) All airfields should be equipped with medium-powered MF beacons.

(b) As is indicated in Table XVII–14, the DCA is faced with the fact that 21 airfields to which UBA aircraft are flown are without any radio control. The initial cost to equip each station is estimated at K52,000 for apparatus and K5,000 for installation. This would provide Aerodrome Control, Internal Service R/T, VHF/DF, and Approach Control, and includes the generators and petrol engines (one standby). The cost of proper housing for apparatus, power, and staff is set at a minimum of K20,000. From this can be seen that to fully equip 21 additional stations the total cost would be approximately K16·2 lakhs. The position is taken by some that, as many of these airfields have but one flight per week and several only two a month, it would be uneconomical to equip them. The opposite position is taken by crew and passengers alike when aircraft are unable to find such airports as Keng Tung somewhere below the low clouds and circled by 5,000 and 6,000-ft. peaks above the level and within ten miles of the airstrip. When the aircraft must return without making a landing, the desirability of signal controls becomes quite apparent. It is recommended that the remaining 21 airfields be equipped with radio control and that any new airfields also be so equipped.

(c) In connection with the equipment requirements of the 21 airports still without radio, it is noted that, in the past, the products of only one manufacturer have been used for all planes and stations. It is possible that costs may be out of line as a consequence. This would also apply to emergency aircraft radio with which aircraft, flying over such terrain as is generally found in Burma, should be equipped as recommended by ICAO. It is recommended that the performance data and costs for the equipment of competing manufacturers be examined in order to obtain the best equipment at the least cost.

(d) It is recommended that the flight crew of all commercial aircraft include a qualified licensed radio operator.

(e) The Preliminary Report recommended that radio operators and maintenance technicians be given training in schools in Burma to be established by GUB. It is now considered advisable that the DCA establish a radio operators' and technicians' school. This school would be available also to the Radio Telecommunications system, the entire GUB military establishment, and the Shipping Board as well as to Civil Aviation. It can be seen that the broader needs of all GUB indicate the continued need of such a school. The DCA is giving training to operators at present but the scope of this training is limited. A good radio operator of any worth should know his equipment well enough to be able to install any part subject to failure. This ability is not acquired from station training, nor are the station operators authorized and qualified by experience to make adjustments and repairs. It is therefore recommended that GUB establish a radio operators' and technicians' school to serve all agencies.

H. ACCOUNTING AND STATISTICS

The financial statement of the UBA for the fiscal year ending September 30, 1951, together with a profit and loss statement, are presented on Table XVII–15 (*see next page*). Comparable figures for the years 1949 and 1950 are shown on the table. The net cash worth of UBA has improved each year. There is now no outstanding indebtedness, and the present gross worth is entirely earned.

Plates 4, 5 and 6 show Comparative Sources of Revenue; Comparative Operating Expenses; and Revenue, Expenditure and Profit. From a study of Table XVII–16, Monthly Traffic Records (*see p. 488*), and Plates 4, 5 and 6, the following can be deduced:

1. Although passenger travel dropped 28% from 1951 to 1952, the revenue dropped only 4%, due mainly to an increase in rates.
2. For the years 1949 and 1950, A/C charter fees exceeded the income from passenger travel.
3. Monthly Traffic Records indicate that passenger traffic has decreased with the decrease in services flown per month, but not in as great a proportion. This tabulation also shows a decrease in route miles per month but not in proportion to the decrease in flight services. This is also true of totals for baggage freight and mail weights handled. The most important conclusion is that the actual flight operations costs have been considerably reduced by better loadings per aircraft and flight. However, the crowding of aircraft with freight to the discomfort of passengers is not consistent with the objectives of providing better services. Nearly a four-to-one heavier loading of passengers and a three-to-one heavier loading of freight occurred in 1952 than in the first six months of 1951.

The accounting and statistical records for UBA, kept at the control terminal building on Strand Road, Rangoon, comply with GUB requirements and are subject to interim and yearly audit of the Accountant-General's office. From the organization chart (Table XVII–9), the department appears to have sufficient personnel to perform its duties. However, the year-end report is delayed too long before issuance. It is recommended that a study be made of the Accounting, Fiscal and Statistical Department, to determine means to increase its efficiency.

I. FUTURE DEVELOPMENTS

Elsewhere in this chapter the following major developments have been mentioned as in progress or planned:

1. Operation of the airport radio by the DCA, as proposed by the Preliminary Report, has been taken over from International Aeradio Ltd.
2. The training of pilots in Burma has been determined uneconomical in comparison with the cost in the United Kingdom and it is planned to send another twelve students there.

TABLE XVII – 15

UNION OF BURMA AIRWAYS

OPERATING ACCOUNT FOR THE PERIOD FROM OCTOBER 1, 1950, TO SEPTEMBER 30, 1951

Rupees in Lakhs 1948–49	Rupees in Lakhs 1949–50		Details 1950–51	Total 1950–51
		To OPERATING EXPENSES		
8·01	20·22	Flying Operation	49,40,257 5 3	
2·10	4·46	Ground Operation	18,12,691 6 1	
5·22	8·81	Traffic, Passengers, Freight Services	8,11,632 0 2	
101·69	138·67	Charter Fees (Leased A/c)	Nil	
117·02	172·16			75,64,580 11 6
40·67	80·54	To Gross Profit transferred to Profit & Loss account		54,54,767 12 9
157·69	252·70			1,30,19,348 8 3

Rupees in Lakhs 1948–49	Rupees in Lakhs 1949–50		Details 1950–51	Total 1950–51
		BY OPERATING REVENUE		
47·73	84·73	Passage	89,72,062 10 3	
20·16	60·54	Freight	18,75,872 15 5	
2·69	4·52	Excess Baggage	3,63,003 3 0	
2·25	3·61	Carriage of Mails	4,24,897 2 7	
84·86*	99·30*	Income from charter (own)	13,83,512 9 0	
				1,30,19,348 8 3
157·69	252·70	*(Income from own and leased aircraft)		1,30,19,348 8 3

PROFIT AND LOSS ACCOUNT FOR THE PERIOD FROM OCTOBER 1, 1950, TO SEPTEMBER 30, 1951

Rupees in Lakhs 1948–49	Rupees in Lakhs 1949–50		Details 1950–51	Total 1950–51
1·80	2·98	To General Administration Expenses		6,22,997 13 3
		To DEPRECIATION		
5·24	8·14	On aircraft, fleets, spares (Dove and Dakota)	13,92,850 2 9	
0·10	0·28	On Plant, Machinery, Ground Equipment	32,941 9 4	
0·57	0·85	On Motor Vehicles	1,03,694 0 0	
0·32	0·22	On Furniture, Fixtures, Office Equipment	41,269 14 0	
		On Buildings and Structures	16,599 3 8	
6·23	9·49			15,87,354 13 9
2·00	2·00	To Reserve for losses due to obsolescence of a/c spares		2,00,000 0 0
2·00	—	Unforeseen Liabilities		Nil
2·32	—	To Loss of aircraft XY-ABP to insurgents		Nil
1·92	1·45	Interest paid on loan received from Government	1,643 13 0	
		Interest paid to Indonesian Airways	160 9 0	
				1,804 6 0
0·50	—	Bad and Doubtful Debts		Nil
0·30	0·30	Proportion of Prel. Expenses written off		29,843 12 0
24·13	64·90			
33·17	68·65	Balance being net profit for the period carried forward to Balance Sheet		30,98,830 12 8
41·20	81·12			55,40,831 9 8

Rupees in Lakhs 1948–49	Rupees in Lakhs 1949–50		Details 1950–51	Total 1950–51
40·67	80·54	By Profit transferred from Operating A/c Incidental Revenue		54,54,767 12 9
0·05	0·06	Booking Cancellation Fees	7,966 13 0	
0·27	0·26	Sundry Receipts	29,799 2 10	
0·32	0·32			37,765 15 10
0·21	0·10	Engineering Job Receipts		
		Interest recd. on Investment Account		8,524 2 0
—	0·04	3 years T. Bonds at 2½% = Rs. 18,78,000	12,784 9 5	
—	0·12	3 months T. Bills at 1% = Rs. 25,00,000	26,989 1 8	
—	0·16			39,773 11 1
41·20	81·12			55,40,831 9 8

BALANCE SHEET AS OF SEPTEMBER 30, 1951

Liabilities

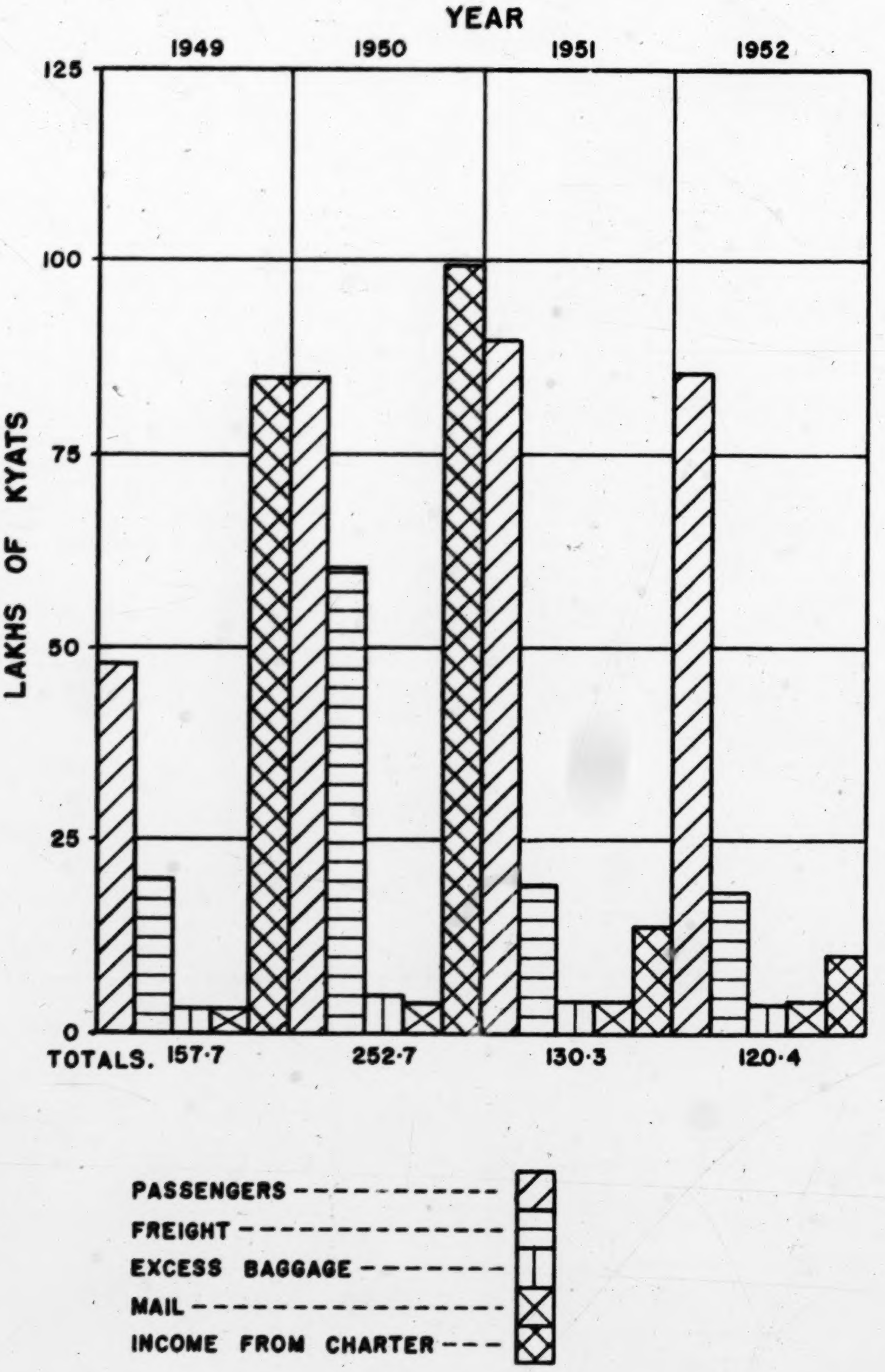
Rupees in Lakhs 1948–49	Rupees in Lakhs 1949–50		Details 1950–51	Total 1950–51
		SANCTIONED CAPITAL		50,00,000 0 0
50·00	25·00	Loan Capital (Balance)	25,00,000 0 0	
		Repayment during 1950–51	25,00,000 0 0	Nil

Assets

Rupees in Lakhs 1948–49	Rupees in Lakhs 1949–50		Details 1950–51	Total 1950–51
		FLEET ACCOUNT AT COST AT 30.9.51		
10·85	10·85	De Havilland Dove Aircraft*	8,14,679 4 6	

		RESERVE ACCOUNT		
—	25·00	Capital Reserve		25,00,000 0 0
4·51	12·54	Depreciation on Aircraft, Aircraft spares, etc. (Last Balance 12,53,774 1 3 + This year 12,47,995 3 4)	25,01,769 4 7	
0·10	0·38	Depreciation Plant, Machinery, W/shop Equipment (Last Balance 37,615 1 2 + This year 32,941 9 4)	70,556 10 6	
0·42	1·27	Depreciation Motor Vehicles (Last Balance 1,27,345 9 4 + This year 1,03,695 0 0)	2,31,040 9 4	
—	—	Buildings and structures	16,599 3 8	
0·26	0·48	Depreciation Furniture Fixture, Office Equipment (Last Balance 47,873 1 8 + This year 41,269 14 0)	89,142 15 8	
5·29	14·67			29,09,108 11 9
2·00	4·00	Reserve for losses on obsolescence of Aircraft and Stores including reserve of Rs. 2,00,000/- made during the year	6,00,000 0 0	
1·92	1·45	Reserve for interest	Nil	
0·15	0·37	Reserve Audit Fees	18,400 0 0	
2·00	1·78	Reserve unforeseen liabilities (Last Balance 1,78,606 8 3 −		
0·50	0·50	This year 32,380 5 0)	1,46,226 3 3	
6·57	8·10	Reserve Bad Debts	50,000 0 0	
				8,14,626 3 3
		SUNDRY CREDITOR/CREDIT BAL.		
10·25	6·53	Sundry Creditors (Trade)	5,07,444 6 8	
1·44	0·72	Sundry Credit Balances	7,38,596 10 4	
11·69	7·25			12,46,041 1 0
0·62	0·45	Sundry Revenue Received in Advance		1,31,884 15 7
—	24·13	Profit and Loss Account as per last Balance Sheet	64,33,193 2 10	
—	0·30	Add: Prior year Rev. Account	64,678 1 7	
—	24·43		64,97,871 4 5	
—		Less: Prior year Expense A/c	1,31,729 1 9	
—	24·43		63,66,142 2 8	
24·13	64.90	Add: Net Profit for the year as per accompanying Profit and Loss Account	30,98,830 12 8	
24·13	89·33		94,64,972 15 4	
—	25·00	Less Transferred to Capital Reserve Account	Nil	
24·13	64·33			94,64,972 15 4
98·30	144·80			1,70,66,633 14 11

—	11·91	Field Aircraft Services Dakota Aircraft, 1949-50 11,90,513 15 2 1950-51 Purchase 4,38,124 2 6	16,28,638 1 8	
10·85	22·76	(*Last Balance 10,85,124 10 0 This year 2,70,445 5 6)		24,43,317 6 2
4·60	7·23	Aircraft Spares, Power Units Engine, Airframe, Propeller Radio, etc. (Dove and Dakota) at cost at 30/9/51	15,70,386 7 9	
0·59	1·12	Plant Machine, i.e. Ground and W/shop Equipment at cost at 30/9/51	1,29,854 12 6	
1·27	2·68	Motor Vehicles at cost at 30/9/51	3,23,269 7 0	
0·30	1·31	Furniture, Fixtures, Office Equipment at cost at 30/9/51	2,09,412 1 2	
—	—	Building at cost at 30/9/51	9,55,286 9 0	
1·83	3·61	Stock of stores, spares on hand as at 30/9/51	75,000 5 3	
—	—	Stock of Fuel Oil on hand as at 30/9/51	11,323 3 6	
0·08	0·18	Stock of Stationery on hand as at 30/9/51	9,189 12 1	
9·27	16·13			32,83,722 10 3
		SUNDRY DEBTORS DEBT BAL.		
32·30	23·75	Sundry Debtors (Trade)	26,43,318 14 7	
4·14	10·42	Sundry Debit Balances	10,02,848 2 5	
1·09	1·31	Insurance Prepaid	2,12,488 0 7	
—	0·40	Prepaid Expenses	1,88,005 9 0	
37·43	35·88			40,46,660 10 7
0·60	0·30	PRELIMINARY EXPENSES	29,843 12 0	
—	—	Less (1950-51) written off Suspense cash lost (case pending in BSI Court)	29,843 12 0	Nil
				37,486 12 0
		INVESTMENTS		
—	9·29	3 years T. Bonds bearing 2½% per annum	18,78,000 0 0	
—	50·00	3 month T. Bills bearing 1% interest per annum	25,00,000 0 0	
—	59·29			43,78,000 0 0
		CASH BALANCE		
35·62	9·43	On current account with the Union Bank, Rangoon	28,12,234 9 11	
4·53	1·01	Office Cash/Cheques	65,211 14 0	
40·15	10·44			28,77,446 7 11
98·30	144·80			1,70,66,633 14 11



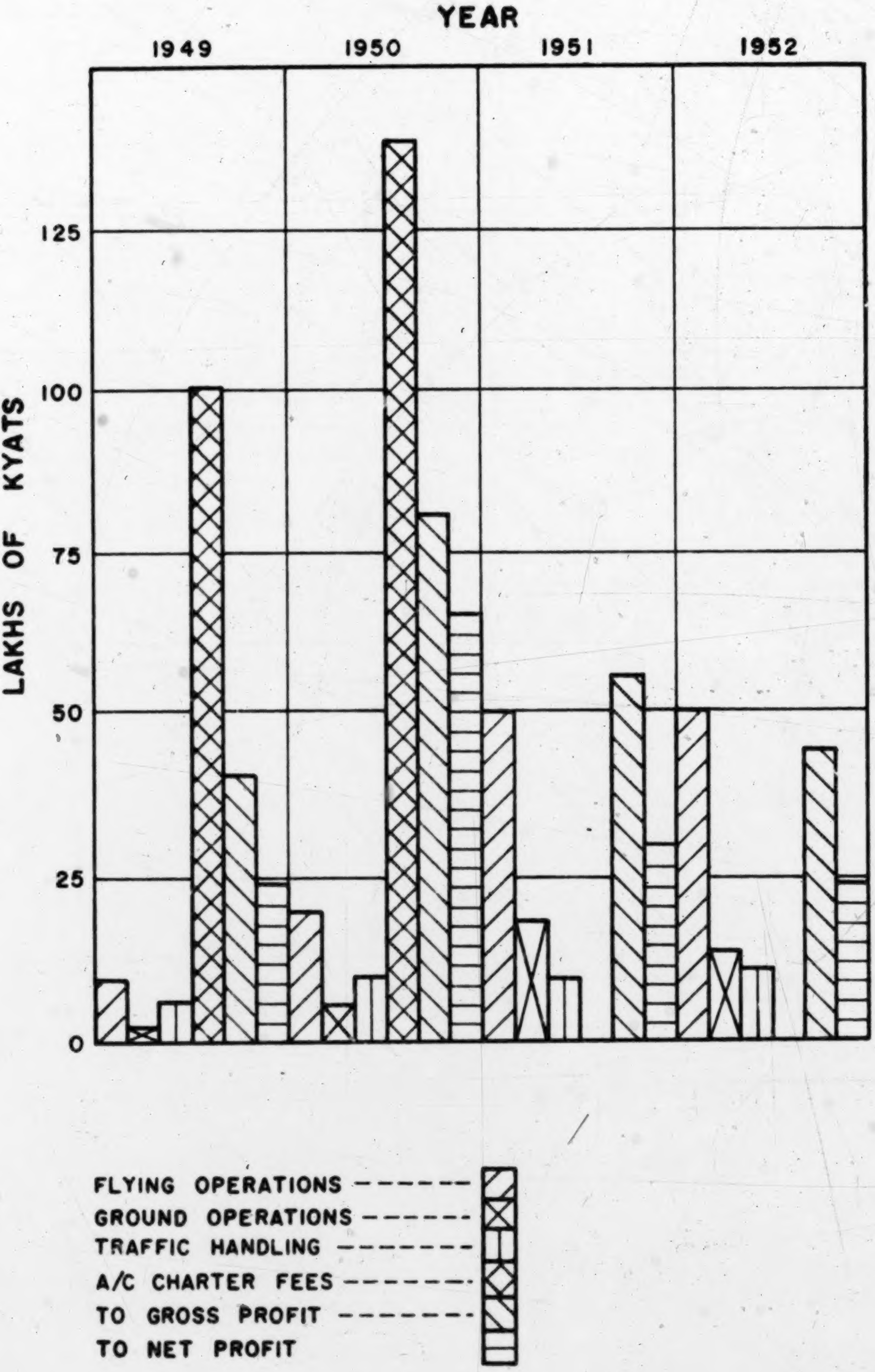
MINISTRY OF NATIONAL PLANNING

UNION OF BURMA AIRWAYS

COMPARATIVE
SOURCES OF REVENUE

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY EJP DATE PLATE
CK. BY EPT MAY 53 NO. 4



MINISTRY OF NATIONAL PLANNING

UNION OF BURMA AIRWAYS

COMPARATIVE OPERATING EXPENSES

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P. DATE PLATE
CK. BY E.P.T. MAY 53 NO. 5.

TABLE XVII – 16

UNION OF BURMA AIRWAYS

TRAFFIC RECORDS

MONTHLY OPERATIONS

Date	*Flights*	*Passengers*	*Baggage (lbs.)*	*Freight (lbs.)*	*Mail (lbs.)*	*Total Wt. (lbs.)*	*Miles*
January 1951	940	15,271	94,934	596,369	32,956	724,259	160,854
February	1,023	15,721	102,285	807,787	31,410	941,482	175,270
March	1,026	17,587	118,835	682,997	39,102	840,934	165,735
April	1,136	19,319	117,015	724,974	32,176	874,165	179,628
May	1,217	20,219	138,027	738,834	34,680	911,541	189,075
June	1,041	13,550	124,460	609,315	33,325	767,100	155,851
July	869	11,721	95,194	612,517	34,295	742,006	138,157
August	725	12,614	92,173	636,904	43,034	772,111	111,755
September	644	11,502	88,931	737,934	35,586	862,451	111,490
October	229	11,114	79,097	527,631	22,743	629,471	129,499
November	272	12,163	84,185	590,073	23,250	697,508	160,819
December	262	11,347	74,415	561,031	26,168	661,614	134,937
Total	9,384	172,128	1,209,551	7,826,366	388,725	9,424,642	1,813,070
January 1952	250	10,482	66,031	542,107	23,994	632,132	118,180
February	263	12,009	58,697	605,613	25,031	689,341	135,088
March	265	12,837	63,207	537,081	23,100	623,388	146,081
April	312	13,092	58,544	383,544	21,491	463,579	150,607
May	267	12,078	70,658	444,309	22,798	537,765	142,929
June	191	8,706	71,216	432,262	22,934	526,412	111,780
July	238	9,132	52,995	463,295	24,820	541,110	126,655
August	243	8,991	51,011	559,402	23,728	634,141	127,499
September	225	7,935	52,293	434,533	21,448	508,274	84,648
October	263	10,002	61,048	487,824	22,154	571,026	124,825
November	255	7,820	59,397	524,351	23,984	607,732	135,020
December	296	11,472	80,503	740,670	25,527	846,700	155,609
Total	3,068	124,556	745,600	6,154,991	281,009	7,181,600	1,558,921

3. Funding of the purchase of new aircraft is approved at the rate of K25 lakhs per year for the next four years.

4. The enlargement of the maintenance shops at Mingaladon is in progress, an additional main hangar has been released by the BAF to UBA, and machine tools are being installed.

5. As proposed in the Preliminary Report UBA is now starting maintenance service of BAF aircraft, having been assigned seven for full servicing.

6. An increase in personnel of not less than 20% is contemplated in the maintenance division.

7. The office of the DCA has prepared, or caused to be prepared, estimates for the program of airport development and improvement. The work at the airports indicated below is to be included in the program for 1953–54 construction.

Work	*Cost Estimate (kyats)*
Akyab. The construction of an all-weather permanent runway. The sanction of the Government to undertake this work will be applied for on receipt of estimates of costs from the PWD at Akyab.	10,00,000
Victoria Point. The construction of an all-weather permanent runway. The sanction of the Government to undertake this work has been requested.	10,00,000
Thayetmyo. The construction of an all-weather permanent runway. The sanction of the Government to undertake this work has been requested.	5,60,000
Mergui. The extension of runway. The PWD at Mergui is preparing a detailed estimate.	2,00,000
Kyaukpyu. Improvements. The EE (B & R) Kyaukpyu Division, reports that the estimate of this work will be submitted after the Superintendent Engineer, Maritime Circle, has determined transverse gradients and paving thickness,	7,50,000
Tavoy. The construction of an all-weather macadam runway. Sanction of the Government to undertake this work has been requested.	3,75,000

Myingyan. The construction of a new airstrip with work to start during 1953–54.	4,20,000
Bassein, Magwe and Heho. Resurfacing. Work at Heho to be carried on during the current 1952–53 season, and Magwe and Bassein during 1953–54.	9,00,000
Momeik. Tar and stone screenings. Sanction of the Government to undertake this work has been requested.	2,64,000
Controlled Airfields. Barbed-wire fencing. Sanction of the Government has been requested.	2,00,000
Controlled Airfields. Provision of labor staff quarters. Sanction of the Government has been requested.	1,17,000
Toungoo, Henzada, Loikaw and Thayetmyo. Radio telecommunications buildings. Sanction of the Government has been requested.	80,000
Sandoway (Mazin). Construction of permanent staff and W/T building. Sanction of the Government has been requested.	30,000
Total	58,96,000

8. Development and improvements are in progress at the following eight airports.

Carry-on Work	*Cost Estimate (kyats)*
Akyab. A new modern terminal building. With construction completion to be by the end of 1954.	3,00,000
Mandalay. A new modern terminal building. With construction completion to be by the end of 1954.	3,00,000
Buthidaung. A new civil aerodrome at this site. Salvaged pierced-steel plank at Akyab has been taken over by the Pyidawtha Committee for this work. This airstrip is near the site of the proposed Saingdin Falls Hydroelectric Project.	3,00,000
Sandoway (Mazin). The construction of a permanent all-weather airstrip. Sanction of the Government has been received. Completion is contemplated in 1954.	7,60,000
Henzada. The construction of an entirely new airfield has been started against an allotment of K50,000 for 1953 with ultimate completion in 1954.	16,00,000
Prome. The construction of a new airfield.	22,23,000
Singaling Khamti. An all-weather runway is under construction with K1,00,000 authorized for 1953 and completion in 1954.	5,04,000
Moulmein. A second seal coat has been started with completion estimated in 1954.	81,000
The estimated total cost of this carry-on work is	60,68,000
The total costs for items 7 and 8 above is the sum of	1,19,64,000

9. *Additional improvements*. The above estimates on close study disclose no re-orientation to windrose directions, no extensive fills or cuts to provide 500-ft. usable widths, and especially no clearing in the approach and departure zones for a distance of two miles from the airstrip. They provide for no transverse drainage. The conditions of the airstrips to which the UBA are scheduling flights are such that on ICAO requirements 27 of the 33 would be condemned.

The cost of the foregoing demand work for the next 12 months is estimated at	K30,00,000
The increase of 100% in the UBA fleet	K60,00,000
Total—Item 9	K90,00,000
Total—Items 7 and 8	K1,19,64,000
Total Budget	K2,09,64,000

J. CONCLUSIONS AND RECOMMENDATIONS

1. PRELIMINARY REPORT RECOMMENDATIONS

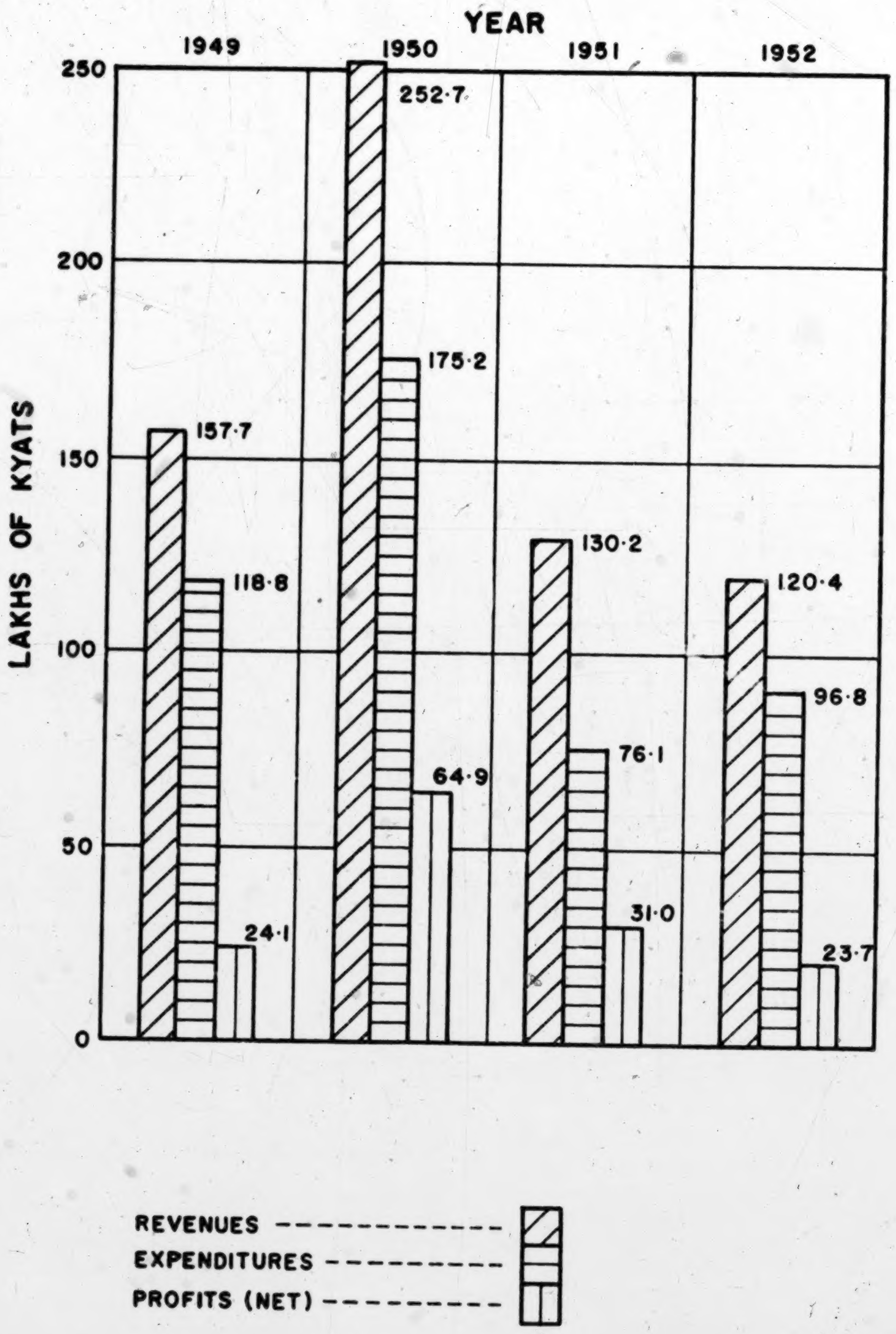
The Preliminary Report reviewed the organization, plant and facilities, traffic flight control, and the fiscal situation of the UBA, and presented certain recommendations. Subsequently, these recommendations were considered by an advisory board on Civil Aviation and Airways on behalf of the subcommittee on Transportation and Communications. This board was composed entirely of Burma Airways and civil aviation officials.

Regulatory commission. The first recommendation of the Preliminary Report found under Section VIII, Transportation, urged the establishment of a regulatory commission to control the four major transport divisions; i.e., railroads, highways, waterways and airways. The advisory board of March 21, 1952, voted against such a regulatory commission. However, although Airways rates are less directly competitive than those of the other transportation systems, a properly representative regulatory body would take all such factors into account and would insure a balanced structure and proper safety practices for the country as a whole.

Maintenance and training. The coordination and improvement of the administrative functions of personnel training, workshop maintenance and a spare-parts supply for civil and military aircraft was considered by the Advisory Board and action thereon is in progress. At present, UBA is maintaining seven BAF aircraft and has obtained a second hangar badly needed to remove repairs from exposure to weather. The BAF, however, is reluctant to discontinue entirely its own maintenance and is presently recruiting mechanics and training them. This may well be justified for military reasons, and no further comment is offered.

Operations training. The Preliminary Report recommended training of pilots, radio operators and maintenance technicians in formal schools to be established in Burma. The advisory board rejected this on the presumption that the need for pilots is very limited. However, it should be noted that pilots of military aircraft must receive an entirely different type training from that received by commercial pilots, the first being taught risk-taking, the second being taught risk-avoidance. Radio operators are more easily obtained, and maintenance technicians are soon shop-trained.

Radio Operation. The Preliminary Report recommended that the operation of the radio and signal network be by the DCA. This is now the case and the expansion of the system is in progress, with the installation of radio at Tavoy and Keng Tung now com-



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UNION OF BURMA AIRWAYS

REVENUE EXPENDITURE AND PROFIT

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pleted, and of radio beacons at Tavoy, Keng Tung, Heho and Lashio in progress. Also an auxiliary beacon is to be located about 100 miles north of Rangoon on the Prome Road.

Aircraft replacement. The Preliminary Report recommended the establishment of a fund for the phased replacement of aircraft. Steps have been taken by the UBA to set aside these funds and the sum of K25 lakhs is annually to be allocated. The purchase of three Marathon, Mark I aircraft late in 1952 was not, however, from these funds.

2. COMPREHENSIVE REPORT RECOMMENDATIONS

For convenience, the various recommendations presented in this chapter are summarized below. It is recommended that:

(*a*) An airlines agency be established to prepare the necessary papers to clear air freight through customs. This service should be rendered free of charge.

(*b*) The Rangoon Post Office close its air pouches not sooner than two hours before departure time.

(*c*) Test flights, advertised in advance, should be made to the airports presently served to determine whether an increase in traffic will result.

(*d*) An airstrip should be constructed at Homalin, approximately half-way between Singaling Khamti and Kalemyo.

(*e*) The Papun airstrip should be developed and flights scheduled immediately upon securing the area.

(*f*) A survey should be made of the Special Division of the Chin Hills to determine the most advantageous site for an airstrip.

(*g*) The number of pilots, co-pilots and radio operators should be increased to 24, and the number of available crews kept at 150% of the number of available planes.

(*h*) The pilot-training program should be made a permanent part of UBA.

(*i*) Non-national crew members should be replaced as soon as the training program permits.

(*j*) A retirement program, financed by GUB, should be initiated for all UBA employees, especially crew members.

(*k*) The personnel of the Maintenance Division, UBA, should be increased up to 20% as recommended by the Superintending Engineer.

(*l*) The agents who have contracted to handle booking and freight for UBA should be required to use experienced labor in handling freight.

(*m*) In DCA, the positions of senior Flying Officer and Supervising Engineer should be filled by qualified individuals. In addition, the Supervising Engineer should be provided with an engineering staff.

(*n*) The aerodrome officers employed at the various airports should be engineering graduates and receive training under the chief aerodrome officers and the Supervising Engineer.

(*o*) Further study be made of the prospective passenger-traffic loads and that the passenger fleet be increased to accommodate these loads.

(*p*) A shuttle service utilizing Dove aircraft should be initiated between Mandalay and all airports lying north of Lanywa and Heho.

(*q*) Daily freight service utilizing C-47 aircraft should be instituted between Rangoon and Mandalay, to be followed by a completely separated freight service for the full system of airports.

(*r*) An inventory of machine tools, hand tools and spare parts should be made, and the necessary tools and spare parts purchased.

(*s*) A program should be prepared and implemented to correct the deficiencies existing at the airfields, as indicated in Table XVII–14, and work should proceed immediately.

(*t*) All airfields, existing and proposed, should be equipped with complete radio control.

(*u*) The performance data and costs for the radio equipment of competing manufacturers should be examined in order to obtain the best equipment at the least cost.

(*v*) The flight crews of all commercial aircraft should include a qualified licensed radio operator.

(*w*) GUB should establish a radio operators' and technicians' school.

(*x*) A study of the systems, supervision and related responsibilities of the accounting department should be made.

(*y*) The system of airports should be enlarged to better serve the outlying districts. Ministers and other officials of these districts should be called upon to assist in locating the new airports.

(*z*) DCA exercise more rigid supervision of the handling of traffic, both by UBA personnel and agents.

(*aa*) A Safety Engineer, reporting only to the Minister of Transport and Communications, be employed to check on the strict compliance with the standard safety recommendations of the ICAO.

COMPREHENSIVE REPORT

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ECONOMIC AND ENGINEERING DEVELOPMENT OF BURMA

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PREPARED FOR THE
GOVERNMENT OF THE UNION OF BURMA

VOLUME II

•

TELECOMMUNICATIONS
POWER
INDUSTRY

•

AUGUST 1953

KNAPPEN TIPPETTS ABBETT McCARTHY
ENGINEERS

IN ASSOCIATION WITH
PIERCE MANAGEMENT, INC.
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CHAPTER XVIII

TELECOMMUNICATIONS

A. INTRODUCTION

1. PURPOSE AND SCOPE

The object of this report is to record and evaluate the findings of a general survey of the functions of the Department of Telecommunications, Ministry of Transport and Communications, and to recommend expanded, supplementary or new services, within the framework of the people's needs and purchasing power.

2. SOURCES OF INFORMATION

Data have been gathered from any and all sources believed to afford factual information. Such records as are available of pre-independence operations have been discussed with departmental officials. District as well as headquarters workings and organization have been observed, and personnel have been interviewed throughout Burma. All of this has involved some 1,800 miles of travel by rail, 1,200 miles by air, and 350 miles by highway beyond Rangoon and its environs. Facilities presently in operation and planned have been analyzed from the standpoints of efficiency and economy. When pertinent, facilities of neighbouring countries have also been studied.

B. HISTORICAL

1. DEVELOPMENT AND PREWAR STATUS

a. Telegraph

The development of communications services in Burma has been closely linked with that of India for about a century. First came the military telegraph which expanded gradually until general public service was opened in 1895. By the beginning of World War II, Burma had an extensive network of telegraph lines involving some 33,000 miles of wire connecting 656 telegraph offices, including two landlines to India, one via Akyab and Chittagong (now in East Pakistan), and one via Tamu and Manipur. Lines from Bhamo into China, and through Moulmein into Siam were abandoned as uneconomic because of their light traffic and the difficulty of maintenance.

b. Telephone

It is recorded that telephone installation in Burma began in 1888, although it was only after 1937 that the smaller communities received such facilities. The tempo of expansion increased until, just before the invasion, the populated areas of Burma enjoyed adequate local and long-distance telephone service. Vacuum-tube repeaters had been introduced in 1922 to improve trunk operation. In 1940, carrier operation was begun on the Rangoon–Prome route so that one line could provide several speech and/or telegraph circuits. All telephone services were operated by the Government's Posts and Telegraphs Department with the exception of the Rangoon and Moulmein exchanges. Plans were being made to take these over when Burma was invaded by the Japanese. Connection to the international radiotelephone network was provided by a link between Rangoon and Madras.

c. Radio

Wireless (radio) was utilized in Burma, as in other nations, for shipping, aeronautical, meteorological, broadcasting and international services. The Posts and Telegraphs Department was responsible for these expanding services and for such licensing and enforcement of national and international regulations as was necessary. Over a half-million messages in various categories were handled by the radio services in the fiscal year 1939–40. It is recalled that the relay through India to the rest of the world was not as efficient as was desired, and message delays caused considerable grumbling. A broadcasting service was inaugurated in 1938, and modern equipment was installed in 1940. Over 6,000 receiver licenses were issued on an annual renewal basis.

2. WAR DAMAGES

It is not essential to this Report that a detailed record of war damage be included, other than to observe that telecommunications facilities were almost completely destroyed either by denial or enemy action. Most of the personnel escaped to India and served brilliantly in the Allied armies, while others were caught by the invaders and forced to work on local projects. If there is any solace at all in this picture of near total destruction of facilities, it is in the fact that the bulk of trained personnel returned to the Department at the end of hostilities.

3. REHABILITATION

Restoration after World War II was speeded through the joint efforts of the British Army Signal

Corps, the Civil Affairs Service (Burma), and the returning civil Government. Equipment from military stocks, some civil-type equipment which had been ordered by the Government-in-exile (Simla), supplemented by such remnants as remained in Burma, were combined to rehabilitate the most important services to prewar effectiveness.

a. Telegraph

By the end of 1947, the telegraph network was largely restored, although certain lines, in particular the one from Prome to Akyab connecting with the line to Chittagong (Pakistan), were abandoned for economic reasons. The more modern practices of using teleprinter and superimposed voice-frequency signals on telephone carrier channels were adopted on a limited scale during this period. It is recorded that up to early 1948, a total of 1,355 miles of earth return telegraph circuit, 5,255 miles of phantom telegraph circuit, and 889 miles of voice-frequency telegraph traffic channels has been put into operation. Inland telegraph traffic was averaging about 190,000 messages for a total of Rs. 10 lakhs per annum.

b. Telephone

The demand for telephone service caused considerable improvisation because of equipment shortages in the years following the war. A more extensive and better trunk (long distance) line system than before, including lines correctly transposed for carrier operation, had been installed by the military. Enough terminal and repeater equipment had been obtained to meet all requirements. Technicians were trained in the necessary installation and operating techniques to round out the new carrier program. It should be noted that by the end of 1946, test calls were put through to New Delhi from Rangoon on an all-carrier circuit. Line construction was slowed in the Delta area by difficult river crossings and marshy terrain, so that the idea of utilizing v.h.f. radio began to receive consideration. However, exchanges and local outside plant were not so well established. Seventy telephone exchanges served about 3,000 subscribers in the towns and cities of Burma, principally with ex-military equipment. The poorest equipment was in use in the city of Rangoon where the program for telephone rehabilitation fared very badly because of engineering and equipment inadequacies. It is to be noted that during the war period the private company which had originally operated this system had been taken over by the Government. At that time, also, radio was being suggested for the Arakan because of both the initial expense of new lines and the difficulty of construction in the face of continuing dacoit attacks.

Trunk operations revenue was obtained as a lump sum in the rental of all telephones having access to the trunk network. This made the average telephone rental a very high figure. There seems to have been no well-organized telephone accounts office to set rates or handle the revenue, which amounted to Rs. 16 lakhs annually.

c. Radio

(1) Foreign Circuits

The tremendous application of radio during the war gave Telecommunications personnel further training in this, the youngest and most versatile of communications media. The prewar arrangement for handling foreign telegraph traffic via the India radio circuit was slow and cumbersome. Consequently, when the British Army Signal Corps established a direct circuit to Colombo from Rangoon, the way was paved for a commercial circuit over the same route. Telecommunications absorbed this high-speed (automatic Morse) operation in mid-1946, and by early 1948 was handling 175,000 messages annually for almost Rs. 6 lakhs in revenue. The Rangoon–Madras radiotelegraph circuit handled Burma's India–Pakistan traffic, although high-speed operation was not utilized because of deficiencies at the India terminal. The traffic volume on this circuit reached about 275,000 messages per year, netting Burma over Rs. 3 lakhs of revenue.

(2) Domestic Circuits

Because of the inaccessibility of some communities to landline facilities, radio stations had been installed to furnish telegraphic contact with the rest of the country. About 30 of these utilized former military equipment. The scarcity of trained personnel, power sources and spare parts so necessary for this operation hampered the program. The fact that it expanded at all speaks well for the ability and courage of the "wireless staff."

(3) Marine Station

The marine radio station at Monkey Point went on the air January 21, 1946, and has operated continuously since then. During the reconstruction period, a new transmitter and antenna system were installed to give the Port of Rangoon a service modern in every respect. Several thousand messages are handled annually with ships at sea.

(4) Police, Aeronautical and Broadcast

A v.h.f. radiotelephone system for the Rangoon Police was installed in 1946, to include ten mobile, 25 fixed, and one headquarters station. The maintenance of this equipment was later assumed by the Police. The broadcasting services were absorbed by the Ministry of Information, and aeronautical radio operation by the Department of Civil Aviation.

From the foregoing picture of telecommunications activities during the rehabilitation period and up to the time of independence, it is obvious that with few exceptions communications facilities were as good as or superior to those destroyed by the war.

4. STATUS AFTER INDEPENDENCE

a. New Department

Prior to independence (January 4, 1948), the telecommunications were directed by the Chief Engineer, Telecommunications, under the Department of Posts and Telegraphs. Because of the close integration of the postal and telegraph services, many towns had combined offices presided over by the local postmasters. The same employees handled both mail and telegrams, and provided reliable and economical service. Effective with independence, however, the two branches were separated, and the telecommunications affairs were put into an independent department whose Director reported to the Deputy Secretary of the parent ministry.

b. Responsibilities

The responsibilities of this new department remained unchanged, and included:

(1) The engineering, construction, operation and maintenance of all domestic and foreign civil telecommunications services, telephone, telegraph and radio.

(2) The maintenance and operation of a maritime radio station at Rangoon to work with ocean shipping.

(3) The installation and maintenance of lines or systems required by other civil branches of the Government.

(4) The licensing of private communications systems, broadcast receivers, amateur radio stations and radio operators.

(5) The handling of Burma's affairs at international telecommunications conventions, and the enforcement of treaty regulations in domestic radio operations.

C. THE INSURRECTION

1. GENERAL

When independence was achieved, there was a flurry of staff changes based on a policy of employing only Burma nationals in government posts. Since Telecommunications had been staffed largely with non-nationals, the release of these trained men had a most depressing effect on the various services. Concurrently with the introduction of this policy there occurred the insurrection with its tremendous destruction and loss of facilities of all categories.

2. TELEPHONE AND TELEGRAPH LINES

Telecommunications does not have an accurate record of the losses suffered by the trunk telephone and telegraph lines systems. The loss is known to be large and widespread, and has effectively ended most long-distance telephone and landline telegraphy. Some equipment has been captured and put to use by the insurgent groups.

3. RADIO

With wire facilities made useless, the responsibility for internal communications became a matter for the Wireless Division of the Department. This emphasis on radiotelegraph communications has strained the resources of the department. Training classes were added to alleviate the shortage of operators, but the whole program appears to have been born of expediency rather than adequate planning. Fortunately, the foreign circuits and the shipping service were beyond the reach of the insurgents, and have continued normal operations.

4. RESULTS

Insurgent damage to landline communications services has been nearly as devastating, at least from the curtailment of operations, as was World War II. Lack of security in many areas has precluded any reliable survey of the extent of the damage and has delayed planning for expanded or new services. Attention to a rehabilitation program is developing slowly. Since the Wireless Division has rallied to handle the bulk of the inland traffic, new thought is being given to eliminating landlines altogether. This latter move, however, is considered uneconomical and unwarranted.

D. THE PRESENT SITUATION

1. LANDLINE FACILITIES

a. Telegraph

Burma Telecommunications has commercial telegraph services over the following circuits:

From	*To*	*Via*
Rangoon	Prome	Tharrawaddy
Mandalay	Lashio	Maymyo Nyaungkio Kyaukme Hsipaw
Prome	Paungde	Thegon
Mandalay	Sagaing	Amarapura

From	*To*	*Via*
Mandalay	Thazi	Kyaukse Meiktila
Rangoon	Nyaunglebin	Pegu Pyuntaza Daiku
Prome*	Shwedaung	
Rangoon CTO*	University College (Rangoon)	
Rangoon*	Mingaladon	
Rangoon*	Insein	Ahlone Kamayut
Rangoon	Pyapon	Twante Maubin Kyaiklat
Rangoon	Yandoon	Maubin
Chauk	Sagu	Singu Salin
Kalaw	Taunggyi	Aungban

* Local circuit operation.

These circuits include 800 miles of line, and 37 telegraph offices. The Burma Railways are not yet accepting prepaid telegrams at telegraph offices in railway stations.

b. Telephone

(1) Trunk Operation

There are 75 telephone exchanges of various sizes, accommodating some 4,500 subscribers. Trunk operation is limited to the following circuits:

From	*To*	*Via*
Rangoon	Tharrawaddy and Prome	Taikkyi
Rangoon	Maubin	Twante
Rangoon	Nyaunglebin	Pegu
Mandalay	Maymyo	(direct)
Mandalay	Sagaing	(direct)
Mandalay	Myitnge	(direct)
Mandalay	Meiktila	Kyaukse Thazi
Maymyo	Lashio	Kyaukme Hsipaw

No repeaters are used in these circuits, and services are of less than commercial quality. Most of the exchanges are isolated and furnish only local service (see Plate 1).

An experimental low-power radio link connects the Rangoon and Moulmein exchanges for limited (primarily government) service. A v.h.f. single channel link, planned several years ago, is now being installed to connect Rangoon, Maubin, Wakema and Bassein. The application of radio to commercial telephony will be covered in some detail under "Burma's Domestic Communications," Section E–2.

There is, as yet, no radiotelephone connection from Burma to other parts of the world. This is regarded as a serious deficiency in the communications system, and is one of the problems confronting the Department for early solution. A project report, "An International Radiotelephone Connection for Burma," has been submitted.

(2) Rangoon and Mandalay Exchanges

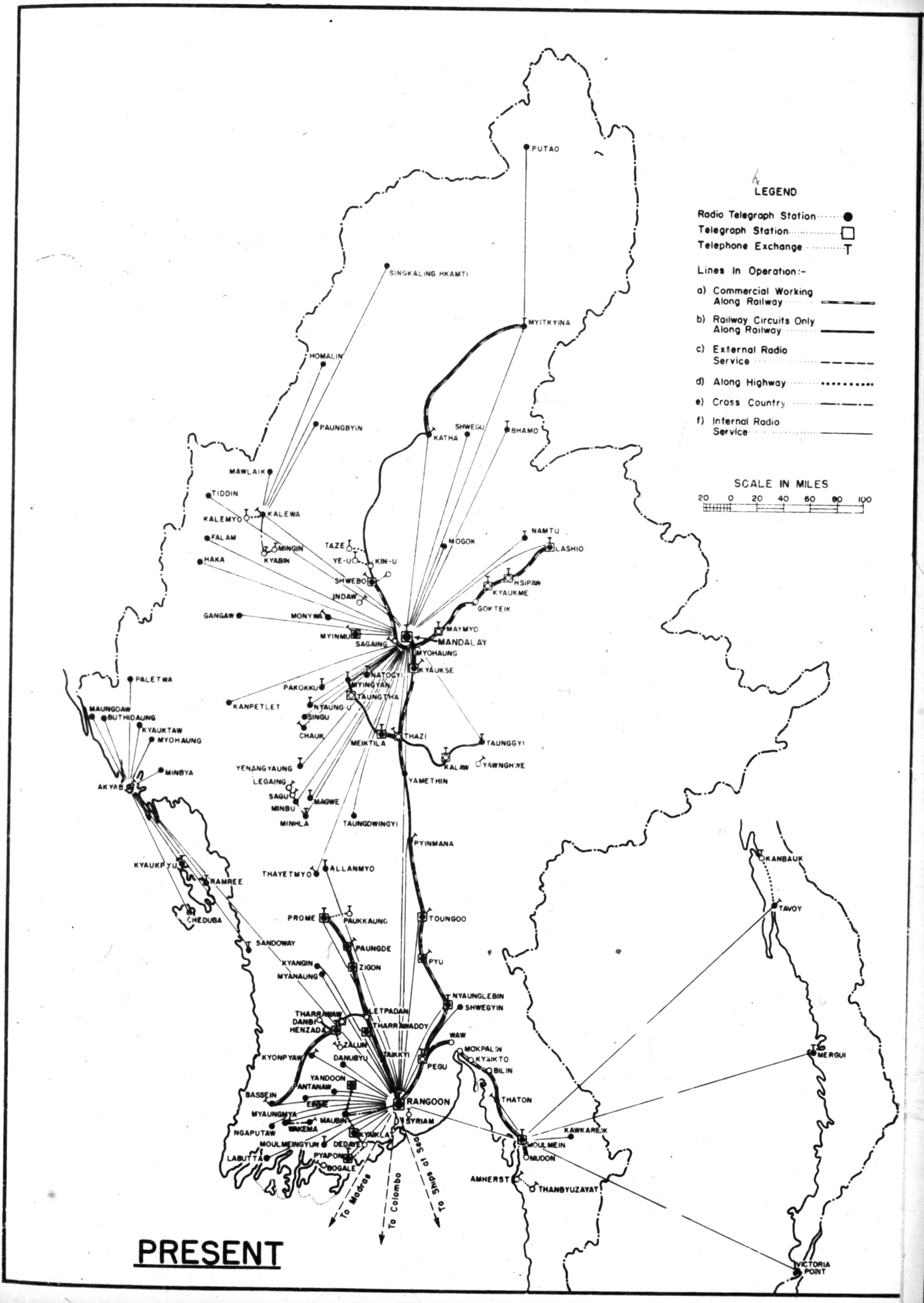
While all of Burma's telephone exchanges are essential, the most important, from the standpoints of size and service rendered, are those of Mandalay and Rangoon. Mandalay, within the past few months, has installed a new 400-line magneto switchboard, and considerable underground cable. With a population of 182,000 this gives a very low saturation figure, even if all of the lines were in use. Once trunk operation to Rangoon is re-established, the demand will increase tremendously.

Rangoon's system is a "hodge podge" of ex-military boards never intended for "big city" operation. Their small capacity necessitates a great deal of transfer operation. This wastes time, reduces the quality of the connection, and increases the possibility of premature cutoff at any of the exchanges involved in the call. There are five exchanges containing 2,618 lines in the system proper, and 97 private branch exchanges (PBX) using 192 junction lines to serve a total of 1,134 telephones.

Disintegration of outside plant, both underground and aerial, has outstripped Telecommunications' maintenance efforts to the extent that satisfactory telephone service is no longer available. This situation is a serious threat to the optimum performance of the new manual auto-ringing boards, and is irreconcilable with full automatic operation.

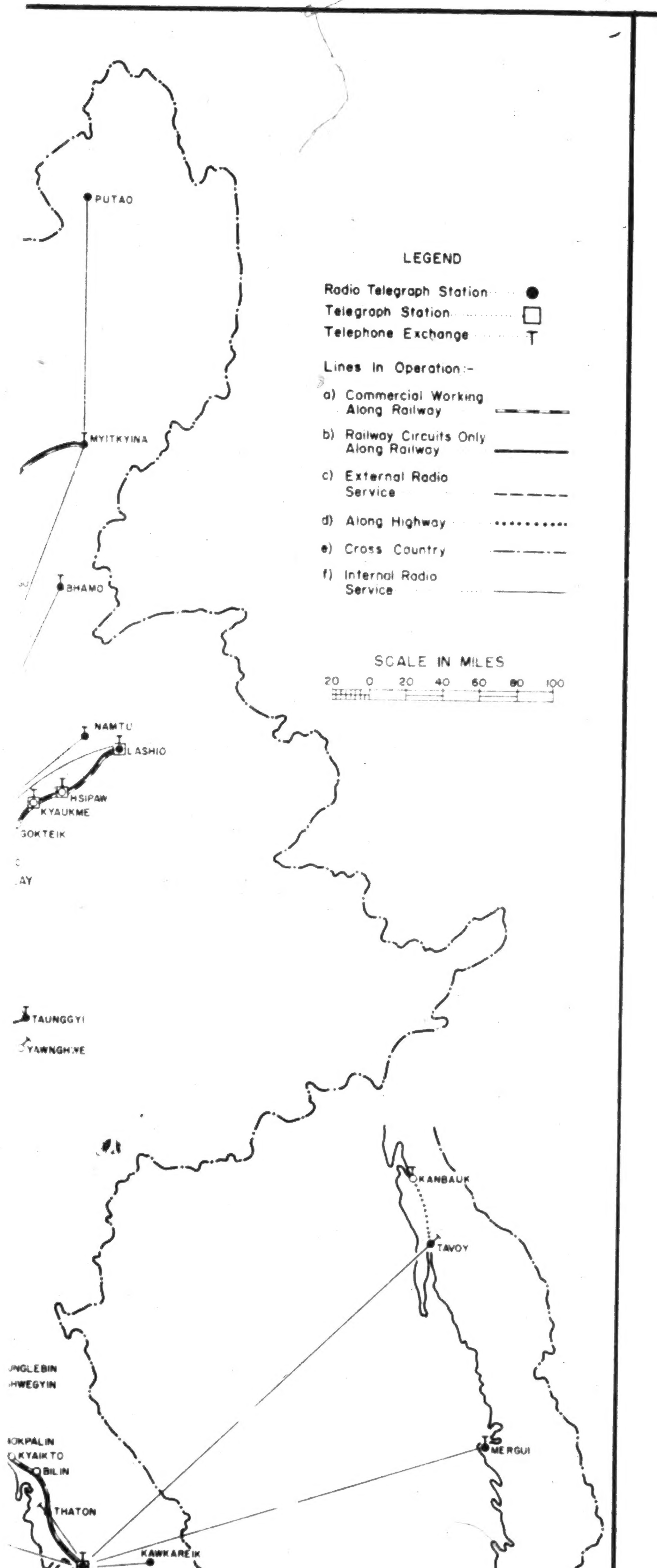
The public has complained about the telephone service, and high annual rate of K600. Plans for conversion to an automatic system have been discussed for years. However, because of the time required for engineering, manufacturing, and installing, it was decided in 1950 that new manual boards should be ordered to alleviate the danger of a creeping paralysis of the exchange system. Units of 1,000 lines which can be broken down into 500, 300, and 200-line sections for future use in the districts, were selected. Two of the three units ordered have already arrived in Rangoon from UK, and installation has begun in the 40th Street Telephone Building. If present plans are realized, these boards should be rendering service within a few months. Further exchange facilities are provided by a 400-line PBX board which has recently been installed in the Secretariat.

Two surveys from which details of an automatic exchange are to be developed have been made in Ran-



PRESENT

LEGEND
Radio Telegraph Station ●
Telegraph Station ☐
Telephone Exchange T
Lines In Operation:-
a) Commercial Working Along Railway
b) Railway Circuits Only Along Railway
c) External Radio Service
d) Along Highway
e) Cross Country
f) Internal Radio Service
SCALE IN MILES
20 0 20 40 60 80 100
PUTAO
SINGKALING HKAMTI
MYITKYINA
HOMALIN
PAUNGBYIN
SHWEGU
BHAMO
KATHA
MAWLAIK
TIDDIN
KALEMYO
KALEWA
FALAM
MINGIN
KYABIN
HAKA
TAZE
YE-U
KIN-U
MOGOK
NAMTU
LASHIO
HSIPAW
KYAUKME
GOKTEIK
SHWEBO
INDAW
GANGAW
MONYWA
MYINMU
SAGAING
MAYMYO
MANDALAY
MYOHAUNG
KYAUKSE
NATOGYI
MYINGYAN
PAKOKKU
TAUNGTHA
KANPETLET
NYAUNG-U
SINGU
CHAUK
MEIKTILA
THAZI
TAUNGGYI
KALAW
YAWNGHWE
PALETWA
MAUNGDAW
BUTHIDAUNG
KYAUKTAW
MYOHAUNG
MINBYA
AKYAB
YENANGYAUNG
LEGAING
SAGU
MINBU
MAGWE
MINHLA
TAUNGDWINGYI
YAMETHIN
PYINMANA
KYAUKPYU
RAMREE
CHEDUBA
THAYETMYO
ALLANMYO
PROME
PAUKKAUNG
TOUNGOO
SANDOWAY
PAUNGDE
ZIGON
PYU
KYANGIN
MYANAUNG
NYAUNGLEBIN
SHWEGYIN
THARRAWAW
DANBI
HENZADA
LETPADAN
THARRAWADDY
ZALUN
WAW
KYONPYAW
DANUBYU
TAIKKYI
PEGU
MOKPALIN
KYAIKTO
BILIN
YANDOON
PANTANAW
BASSEIN
EINME
RANGOON
SYRIAM
MYAUNGMYA
MAUBIN
WAKEMA
NGAPUTAW
KYAIKLAT
MOULMEINGYUN
DEDAYE
LABUTTA
PYAPON
BOGALE
To Madras
To Colombo
To Ships at Sea
THATON
KAWKAREIK
MOULMEIN
MUDON
AMHERST
THANBYUZAYAT
KANBAUK
TAVOY
MERGUI
VICTORIA POINT


PUTAO
MYITKYINA
BHAMO
NAMTU
LASHIO
HSIPAW
KYAUKME
GOKTEIK
AY
TAUNGGYI
YAWNGHWE
KANBAUK
TAVOY
UNGLEBIN
HWEGYIN
OKPALIN
KYAIKTO
BILIN
THATON
KAWKAREIK
MOULMEIN
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LEGEND
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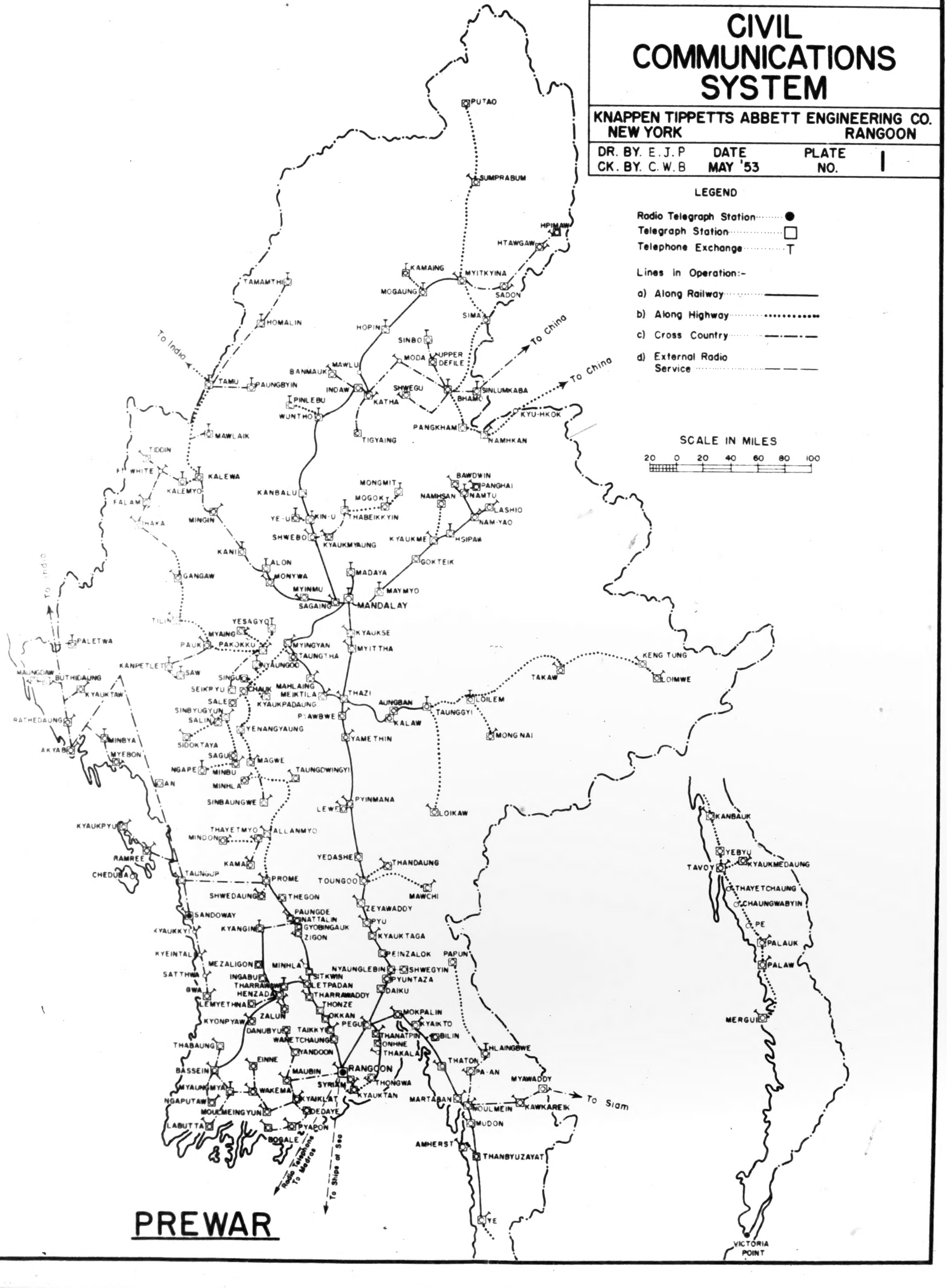
e) Cross Country
f) Internal Radio Service
SCALE IN MILES
20 0 20 40 60 80 100

MINISTRY OF NATIONAL PLANNING

CIVIL COMMUNICATIONS SYSTEM

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. E. J. P
CK. BY. C. W. B
DATE MAY '53
PLATE NO. 1


LEGEND
Radio Telegraph Station ●
Telegraph Station ☐
Telephone Exchange T
Lines in Operation:-
a) Along Railway
b) Along Highway
c) Cross Country
d) External Radio Service
SCALE IN MILES
20 0 20 40 60 80 100
PUTAO
SUMPRABUM
HPIMAW
HTAWGAW
KAMAING
MYITKYINA
MOGAUNG
SADON
TAMAMTHI
SIMA
HOMALIN
HOPIN
SINBO
To China
To India
MODA
UPPER DEFILE
BANMAUK
MAWLU
To China
TAMU
PAUNGBYIN
INDAW
SHWEGU
SINLUMKABA
KATHA
BHAMO
PINLEBU
WUNTHO
KYU-HKOK
PANGKHAM
NAMHKAN
MAWLAIK
TIGYAING
TIDDIN
FT WHITE
KALEWA
KALEMYO
BAWDWIN
MONGMIT
PANGHAI
KANBALU
NAMTU
MOGOK
NAMHSAN
LASHIO
FALAM
MINGIN
YE-U
KIN-U
THABEIKKYIN
NAM-YAO
HAKA
SHWEBO
KYAUKMYAUNG
KYAUKME
HSIPAW
KANI
ALON
GOKTEIK
To India
GANGAW
MONYWA
MADAYA
MYINMU
MAYMYO
SAGAING
MANDALAY
TILIN
YESAGYO
KYAUKSE
PALETWA
PAUK
MYAING
PAKOKKU
MYINGYAN
MYITTHA
TAUNGTHA
KENG TUNG
KANPETLET
NYAUNGOO
TAKAW
MAUNGDAW
BUTHIDAUNG
SAW
LOIMWE
SINGU
SEIKPYU
CHAUK
MAHLAING
MEIKTILA
THAZI
KYAUKTAW
SALE
KYAUKPADAUNG
AUNGBAN
LOILEM
SINBYUGYUN
PYAWBWE
KALAW
TAUNGGYI
RATHEDAUNG
SALIN
YENANGYAUNG
MONGNAI
AKYAB
MINBYA
YAMETHIN
MYEBON
SIDOKTAYA
SAGU
MAGWE
NGAPE
MINBU
TAUNGDWINGYI
AN
MINHLA
SINBAUNGWE
PYINMANA
LEWE
LOIKAW
KANBAUK
KYAUKPYU
THAYETMYO
ALLANMYO
MINDON
YEDASHE
YEBYU
RAMREE
THANDAUNG
TAVOY
KYAUKMEDAUNG
KAMA
CHEDUBA
TAUNGUP
PROME
TOUNGOO
THAYETCHAUNG
MAWCHI
CHAUNGWABYIN
SHWEDAUNG
THEGON
ZEYAWADDY
PAUNGDE
NATTALIN
PYU
PE
SANDOWAY
GYOBINGAUK
KYAUKTAGA
KYAUKKYI
KYANGIN
ZIGON
PALAUK
PEINZALOK
PAPUN
KYEINTALI
MEZALIGON
MINHLA
NYAUNGLEBIN
SHWEGYIN
PALAW
SATTHWA
INGABU
SITKWIN
PYUNTAZA
THARRAWAW
LETPADAN
DAIKU
GWA
HENZADA
THARRAWADDY
LEMYETHNA
THONZE
MOKPALIN
MERGUI
KYONPYAW
ZALUN
OKKAN
KYAIKTO
PEGU
DANUBYU
TAIKKYI
THANATPIN
BILIN
THABAUNG
WANETCHAUNG
ONHNE
HLAINGBWE
THAKALA
YANDOON
EINNE
THATON
BASSEIN
MAUBIN
RANGOON
PA-AN
MYAWADDY
MYAUNGMYA
SYRIAM
THONGWA
To Siam
WAKEMA
KYAUKTAN
NGAPUTAW
KYAIKLAT
MARTABAN
MOULMEIN
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BOGALE
AMHERST
THANBYUZAYAT
Radio Telephone To Madras
To Ships at Sea
YE
VICTORIA POINT

PREWAR

goon. The first was concluded two years ago by BPO, London, under contract with GUB, but final specifications have not been submitted. The second survey was recently concluded by engineers of the L. M. Ericsson Co., Stockholm, at no cost to Government. Specifications have been proposed by this firm and a price quoted to the Ministry. This latter survey is based on the recommendation by the authors of this Report that the modern crossbar system be considered before committing Rangoon to the much older Strowger system recommended by BPO. A project report entitled, "An Automatic Telephone System for Rangoon," and embodying these recommendations has been submitted. It is planned to house the selected exchange in a functional building located to the West of Sule Pagoda Road, between Dalhousie and Fraser Streets.

Maintenance for the present system leaves much to be desired. Lack of adherence to standards, planning, spare parts and materials, tools and facilities is critical. Records and maps are incomplete and deficient in test data. The greatest need, however, has been for a technically and administratively trained organization whose sole function is to manage and operate the Rangoon telephone system. On the recommendation of the authors, this need was recognized and a divisional engineer appointed.

2. RADIO

The inland telegraph service is almost completely a radio service. At the moment, 66 stations are connected to Rangoon, or to each other in several nets so that traffic can move from one end to the other of Burma by relay. Plate 1 indicates the stations now in operation, and includes those now planned for installation this year. The message service is generally considered slow. The public, as well as Government, has complained about the time required for telegrams to reach their destinations via this radio system. For example, messages relayed but once, at Mandalay, required 26 hours to reach Kalewa from Rangoon. These shortcomings inherent in a high-frequency radio net have been pointed out previously (see Interim Report, page 248).

Two circuits handle Burma's communications with the outside world. The Rangoon–Madras link clears traffic to and from India and Pakistan, while the Rangoon–Colombo circuit handles the rest. All Rangoon transmitters, foreign and domestic circuits, are located in a rented bungalow at the 6½ Mile, Prome Road, and the receivers are housed on the second floor of the 40th Street Telephone Building. Keying and order circuits are carried over telephone lines from the Central Telegraph Office. By no stretch of the imagination are these facilities even moderately satisfactory. The crowning deficiency is the lack of space for the essential directional antennas.

By existing commercial standards, Burma's transmitters cannot be classified as "high-powered." For the primary foreign circuits, three 1·2-kW, Standard Telephone, Ltd., units are available. For secondary foreign and divisional headquarters circuits, three 300-watt RCA transmitters are utilized. To operate over shorter distances to district stations ten 50-watt transmitters of both modern and former military types are provided. Effective radiated power is reduced through interaction and absorption between the crowded antennas. Several Marconi 300-watt transmitters were ordered recently for use in Rangoon and district headquarter stations.

The receiving facilities by commercial standards are less satisfactory than those for transmitting. No diversity grouping is possible, and the antennas are limited to simple vertical "whips." In all, there are 18 receivers, old military or ancient commercial units. Expansion plans for seven more are being implemented.

The use of substandard equipment and systems has a most derogatory influence on the service. However, foreign traffic fares much better in this respect than does local inland traffic.

3. ORGANIZATION

The Director of Telecommunications is the Chief Executive of the Department, and reports directly to the Deputy Secretary of the Ministry. To assist him, the Director has a Deputy and two Personal Assistants, one for Engineering and one for Traffic. The Department is divided into five main divisions:

(*a*) The Burma Wireless (Radio) Division under the Divisional Engineer, Wireless, at Rangoon, with responsibility for all the Department's radio matters in Burma.

(*b*) The South Burma Division (Telegraphs) under the Divisional Engineer, Telegraphs, at Rangoon, dealing with engineering, traffic, telegraph and telephone (except the Rangoon telephone system) matters in lower Burma.

(*c*) The North Burma Division (Telegraphs) under the direction of the Divisional Engineer, Telegraphs, at Maymyo, with similar responsibilities in Upper Burma.

(*d*) The Independent Arakan Division, under the direction of the Officer in Charge, Telecommunications, Akyab, with similar responsibilities in that area.

(*e*) The Rangoon Telephone Division under the Divisional Engineer, Telephones (Rangoon) deals with engineering, management and operation of the Rangoon telephone system.

The Director also has reporting directly to him the

Superintendent of each of the following important posts:

Telecommunications Stores, Rangoon.
Central Telegraph Office, Rangoon.
Central Telegraph Office, Mandalay.

Further details are shown in the Organization Chart.

E. TELECOMMUNICATIONS OPERATIONS, PLANS AND PROBLEMS

1. BURMA'S FOREIGN COMMUNICATIONS CIRCUITS

a. General

Planning new and improving existing foreign circuits involves both radiotelephone and radiotelegraph activities. Because they will supplement each other in Burma's communications pattern, and will share housing and operating facilities, it is advantageous to treat them together. Since efficient dependable foreign circuits are second only to dependable domestic communications for the welfare of the country, these matters must receive prompt consideration.

b. Present Traffic Situation

(1) Routes

At the moment, two radiotelegraph circuits handle Burma's foreign traffic. One of these works between Rangoon and Madras with messages to and from India, Pakistan and Ceylon. The other circuit, between Rangoon and Colombo, where it connects into the world network of Cable and Wireless, Ltd., handles all other foreign traffic.

(2) Message Totals

Spot checks reveal that weekly totals (in both directions) average around 5,250 messages over the Rangoon–Madras circuit, and 8,200 over the Rangoon–Colombo circuit. The Madras circuit at times requires up to three Rangoon transmitters, one automatic Morse, and two manual circuits. The Colombo circuit usually clears its traffic with one automatic Morse circuit, but when necessary another can be added. By Western standards, these circuits cannot be considered either fast or heavily loaded, but there are many complaints from the distant terminals about the quality of the Burma signals which at times are unreadable. The difficulties under which they operate are substantial, but not insurmountable.

c. Improvement Possible

(1) Location

Any communications link utilizing the high-frequency spectrum is subject to various kinds of transmission difficulties. While these cannot be entirely avoided, their effects can be minimized by the application of certain radio-engineering principles. The failure to locate the transmitting and receiving stations in surroundings sufficiently adaptable to directional antennas is responsible for a large measure of the present substandard operation. Until these locations have been corrected, optimum operation cannot be achieved.

(2) Frequency Shift Keying

Keying a transmitter by shifting its frequency a small amount offers an important advantage over the conventional on-off method. The effects of noise on the operation of frequency-shift keyed circuits are reduced considerably. A signal-to-noise ratio of but six decibels permits satisfactory operation. This means that any given circuit will be "commercial" rather than "marginal" for a greater portion of the day. Obviously, Burma's transmitters can be made more efficient by adopting f.s.k.

(3) Diversity Reception

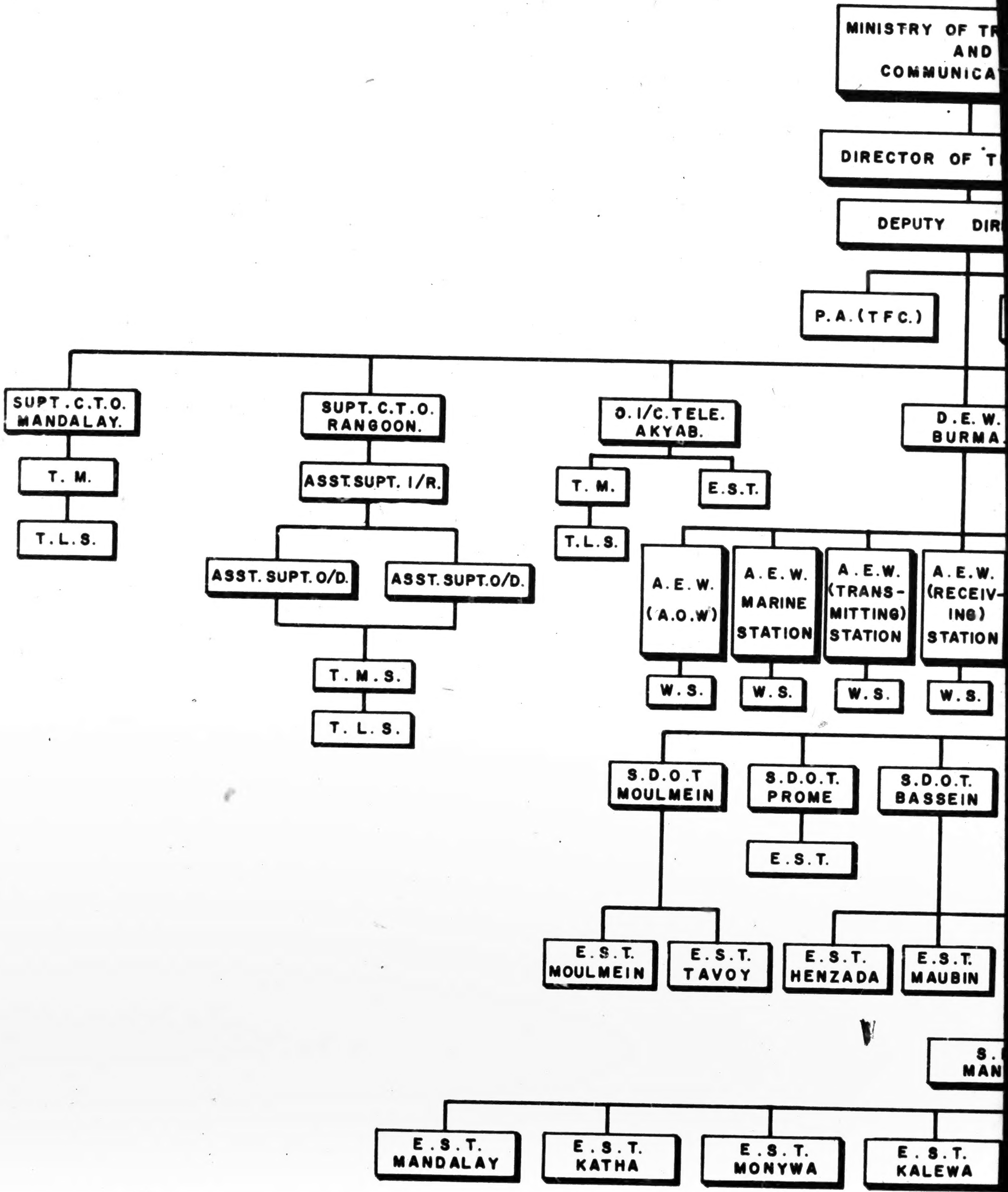
For commercial operation, the principal circuit requirement is that the received signal-to-noise ratio be above a certain minimum, even in deep fades. Because enormous power increases would be necessary to make a noticeable improvement, it is far more effective to apply every possible means for decreasing the fading range than to increase power. Since the gain in circuit performance due to diversity reception varies with the degree of reliability of the circuit, the improvement may be of the order of from 12 to as much as 30 decibels. To achieve this by increasing transmitter power would be a most unrealistic approach. Consequently, space diversity reception (not used heretofore by Telecommunications) should be utilized at both ends of the circuit.

(4) Teleprinter

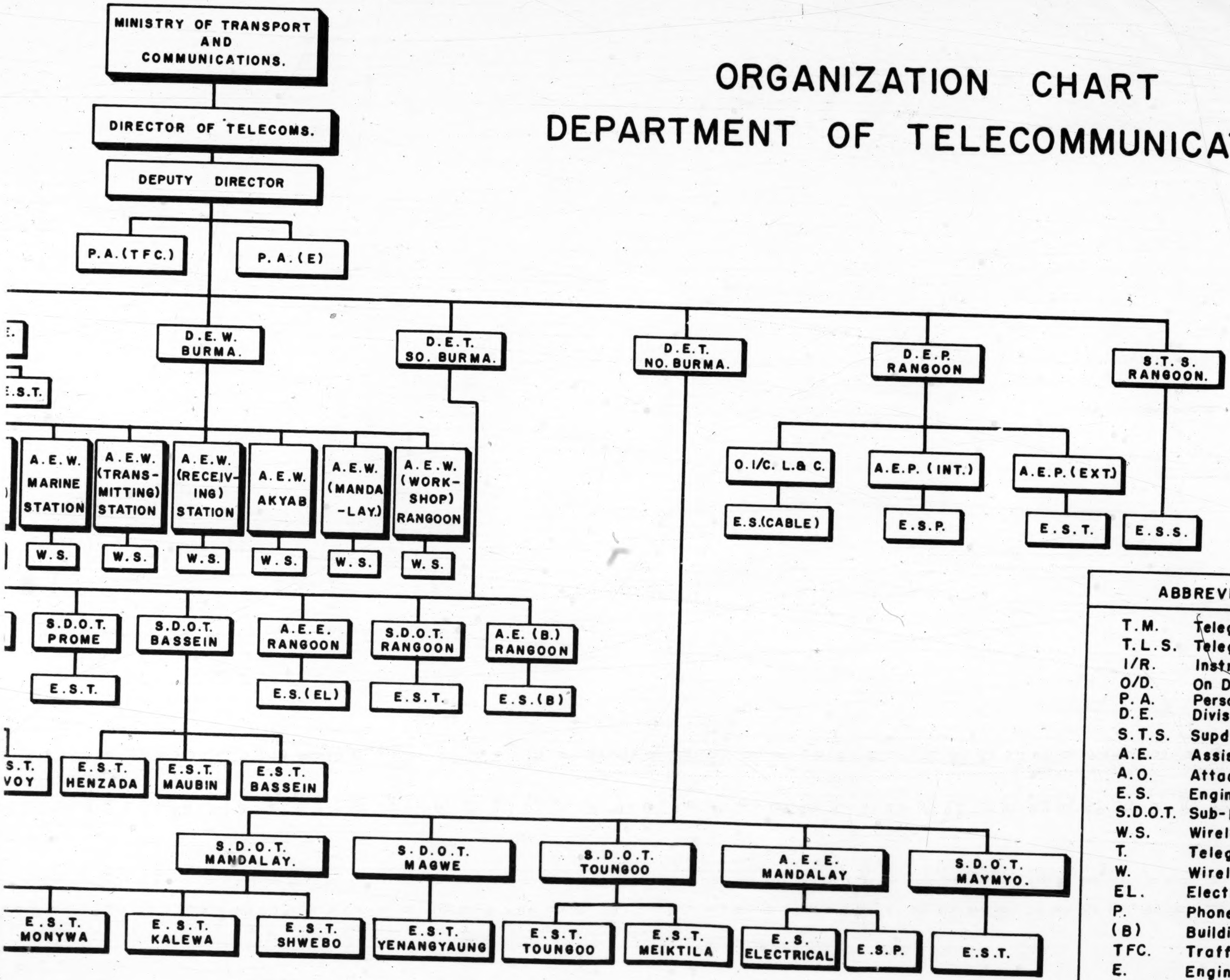
In discussing telegraph-traffic handling, it must be observed that automatic Morse operation has had its day, and is being supplanted by teleprinter at an ever-increasing rate. The adoption of teleprinter has always resulted in higher traffic volumes, faster service, lower rates and greater accuracy. Few telecommunications administrations feel that they can afford to ignore this modern trend.

(5) Possible Economies

To summarize, if one of Telecommunications' 1·2-kW transmitters utilizing frequency shift keying (f.s.k.) were worked into a properly designed direc-


MINISTRY OF TR
AND
COMMUNICA
DIRECTOR OF T
DEPUTY DIR
P.A. (TFC.)
SUPT. C.T.O. MANDALAY.
T. M.
T.L.S.
SUPT. C.T.O. RANGOON.
ASST. SUPT. I/R.
ASST. SUPT. O/D.
ASST. SUPT. O/D.
T.M.S.
T. L. S.
O. I/C. TELE. AKYAB.
T. M.
T.L.S.
E.S.T.
D.E.W. BURMA.
A.E.W. (A.O.W)
W.S.
A.E.W. MARINE STATION
W.S.
A.E.W. (TRANSMITTING) STATION
W.S.
A.E.W. (RECEIVING) STATION
W.S.
S.D.O.T MOULMEIN
E.S.T. MOULMEIN
E.S.T. TAVOY
S.D.O.T. PROME
E.S.T.
S.D.O.T. BASSEIN
E.S.T. HENZADA
E.S.T. MAUBIN
S.
MAN
E.S.T. MANDALAY
E.S.T. KATHA
E.S.T. MONYWA
E.S.T. KALEWA

ORGANIZATION CHART
DEPARTMENT OF TELECOMMUNICATIONS.


MINISTRY OF TRANSPORT AND COMMUNICATIONS.
DIRECTOR OF TELECOMS.
DEPUTY DIRECTOR
P.A. (TFC.)
P.A. (E)
D.E.W. BURMA.
D.E.T. SO. BURMA.
D.E.T. NO. BURMA.
D.E.P. RANGOON
S.T.S. RANGOON.
E.S.T.
A.E.W. MARINE STATION
A.E.W. (TRANSMITTING) STATION
A.E.W. (RECEIVING) STATION
A.E.W. AKYAB
A.E.W. (MANDA-LAY.)
A.E.W. (WORKSHOP) RANGOON
W.S.
W.S.
W.S.
W.S.
W.S.
W.S.
O.I/C. L.& C.
A.E.P. (INT.)
A.E.P. (EXT.)
E.S.(CABLE)
E.S.P.
E.S.T.
E.S.S.
S.D.O.T. PROME
S.D.O.T. BASSEIN
A.E.E. RANGOON
S.D.O.T. RANGOON
A.E. (B.) RANGOON
E.S.T.
E.S. (EL)
E.S.T.
E.S. (B)
S.T. VOY
E.S.T. HENZADA
E.S.T. MAUBIN
E.S.T. BASSEIN
S.D.O.T. MANDALAY.
S.D.O.T. MAGWE
S.D.O.T. TOUNGOO
A.E.E. MANDALAY
S.D.O.T. MAYMYO.
E.S.T. MONYWA
E.S.T. KALEWA
E.S.T. SHWEBO
E.S.T. YENANGYAUNG
E.S.T. TOUNGOO
E.S.T. MEIKTILA
E.S. ELECTRICAL
E.S.P.
E.S.T.

ABBREVIATED DESIGNATION.

T.M.	Telegraph Masters.
T.L.S.	Telegraphists.
I/R.	Instrument Room.
O/D.	On Duty.
P.A.	Personal Assistant
D.E.	Divisional Engineer.
S.T.S.	Supdt. Telecoms. Stores.
A.E.	Assistant Engineer.
A.O.	Attached Officer.
E.S.	Engineering Supervisor.
S.D.O.T.	Sub-Divisional Officer Telecoms.
W.S.	Wireless Supervisor.
T.	Telegraphs.
W.	Wireless.
EL.	Electrical.
P.	Phones.
(B)	Buildings.
TFC.	Traffic.
E.	Engineering
C.T.O.	Central Telegraph Officer.
O I/C.	Officer-In-Charge.
L.& C.	Lines and Cables.
S.	Stores.
(INT.)	Internal.
(EXT)	External.

tional antenna on a frequency suitable for the distance and time of day, and the signal at the distant point was picked up by directional antennas and diversity receivers, one efficiently handled teleprinter circuit could handle the Burma–India traffic. This is true also of the Colombo circuit. Telecommunications can therefore defer buying higher powered telegraph transmitters until the present units are worn out.

(6) Cost Estimate

Frequency shift keying can be added to the Madras and Colombo transmitter for a very modest sum. Conversion to teleprinter operation would add little more to the investment, and could release skilled man-power for other operating duties at the Central Telegraph Office.

No. Required		*Unit Cost Kyats*	*Total (Foreign Exchange)*
2	Frequency Shift Exciter	10,000	20,000
2	Frequency Shift Converter	7,000	14,000
2	Telegraph Converter	4,500	9,000
3	Teleprinter (No. 15 Send-Receive)	6,000	18,000
–	Spare Parts		5,000
	Total		K66,000

However, this modest modernization scheme, regardless of its desirability, cannot be implemented into maximum effectiveness until the long-pending receiver and transmitter centers are in operation.

d. New Circuits Desirable

Direct telegraphic connections to other neighboring countries are desirable, but full-time circuits cannot be justified from the direct revenue standpoints. To illustrate this point, the following table lists the number of messages handled in an average week's operations:

Burma	*UK*	*USA*	*Thailand*	*Indonesia*	*Phil. Rep.*
Outgoing Mgs.	797	138	61	67	5
Incoming Mgs.	746	175	47	18	3
Total	1,543	313	108	85	8

It is quite possible to connect with various countries on a split-schedule for periods long enough to handle mutual traffic. However, until those arrangements are made and until the facilities are at hand for carrying them out, it is necessary to continue to work through Colombo at the higher rates and accepting the delays in the requisite relay operations. Plate 2 shows several desirable radio routes in relation to Rangoon.

e. Revenue

Telecommunications' financial records for 1951–52 foreign and domestic telegraph services are as follows:

Total Earned	K38,53,671.42
Total Expenditure (Salaries and Materials	K9,52,953.73

f. International Radiotelephone Link

(1) General

Burma's telephone system was connected to India's telephone network by a radio link from 1936 until the beginning of World War II. This facility has never been re-established in spite of the insistent demand for it. The Department of Telecommunications has arranged with Indian P. & T. to commence operations between Madras and Rangoon at some future date. The Radio Section of the Department planned the necessary technical facilities, and prepared a specification for equipment to which tenders were submitted late in 1952 by several European and American manufacturers. A project report covering this whole matter has been submitted.

(2) Selection of Equipment

Early in their correspondence, Telecommunications had been urged by India P. & T. to use equipment identical to that installed in their Madras station. Consequently, Telecommunications contacted Westinghouse, USA, for particulars and prices of their "MW" combination which features telegraph and telephone transmitters operating from a common power supply. This equipment meets the need of administrations requiring heavy traffic-handling capacity, but does not represent the "best buy" for Burma in this case, inasmuch as a radiophone system only is required.

(3) Review of Planning

(a) Amplitude modulation. Since an amplitude modulated (A3) system was originally planned, it is believed that Telecommunications is not evaluating correctly the advantages of the Single Sideband Suppressed Carrier (A3a) or Independent Sideband (A3b) operation as used by many overseas telephone services.

(b) Route and terminal. Incomplete planning is also evident in agreeing to the location of the Indian terminal at Madras which requires a carrier connection across the sub-continent to Poona, for all relays beyond India. The standard telephone toll rate between Madras and Poona is Rs. 8–10 which will increase the total charge appreciably, without benefit to Burma. Wire transmission over that distance will also degrade the signal, and is more subject to interruptions. Calcutta is scheduled to have a direct radiotelephone connection with UK in the very near future (a Calcutta–London radiotelegraph circuit was opened in March 1953), certainly by the time Burma's overseas telephone can be put into operation. The transmission path between Rangoon and Calcutta is 450 miles (40%) less than that between Rangoon and Madras. A cursory examination of Burma–India telegrams over a period of a few days shows about equal distribution between the Madras area and the Calcutta area. Since radiotelephone calls might be expected to follow the same pattern, there are good reasons for reconsidering the route of this proposed link.

(4) Single and Independent Sideband Operations

(a) Advantages. In conventional amplitude modulation (AM), the transmitted carrier requires two thirds of the power, and yet serves no useful purpose after modulation. In Single Sideband Suppressed Carrier and Independent Sideband systems, the carrier is suppressed, and in SSSC one of the sidebands is dropped. There is therefore a material saving in transmitting power. Since the transmitted signal requires less spectrum space, the receiver can be made more selective to provide a better signal-to-noise ratio. Consequently, interference is reduced. With the carrier generated in the receiver, selective fading is of little consequence, and the signal is further improved. When all of these advantages are integrated, the use of SSSC is equivalent to a nine-decibel increase (factor of eight) of transmitter power.

One or two telegraph (or teleprinter) channels can be transmitted simultaneously with the voice channel to provide a reliable combined service. When ISB is used, the power-consuming carrier is suppressed, and both sidebands are transmitted to carry separate intelligence channels. In this arrangement, one transmitter can accommodate as many as four voice channels, or an equivalent band-width combination of voice and telegraph channels.

(b) Disadvantages. Both ISB and SSSC equipment are more expensive than AM, and more difficult to adjust and maintain. When considered from standpoints of cost per channel, and greater reliability, however, the advantages far outweigh the disadvantages as attested by their increasing popularity on overseas circuits. Unfortunately, AM and SSSC equipment are incompatible for commercial operation.

(5) India's Equipment

The Indian P. & T. has invested heavily in AM equipment (Westinghouse, USA) for internal radiotelephone circuits, and expected (at last intimation) to use the same on the Burma–India link. It is possible that they will change their view (they already use SSSC on the Poona–London circuit) if Burma approaches them with a plan showing the mutual advantages of SSSC on the India–Burma link.

(6) Expansion of Overseas Telephone Service

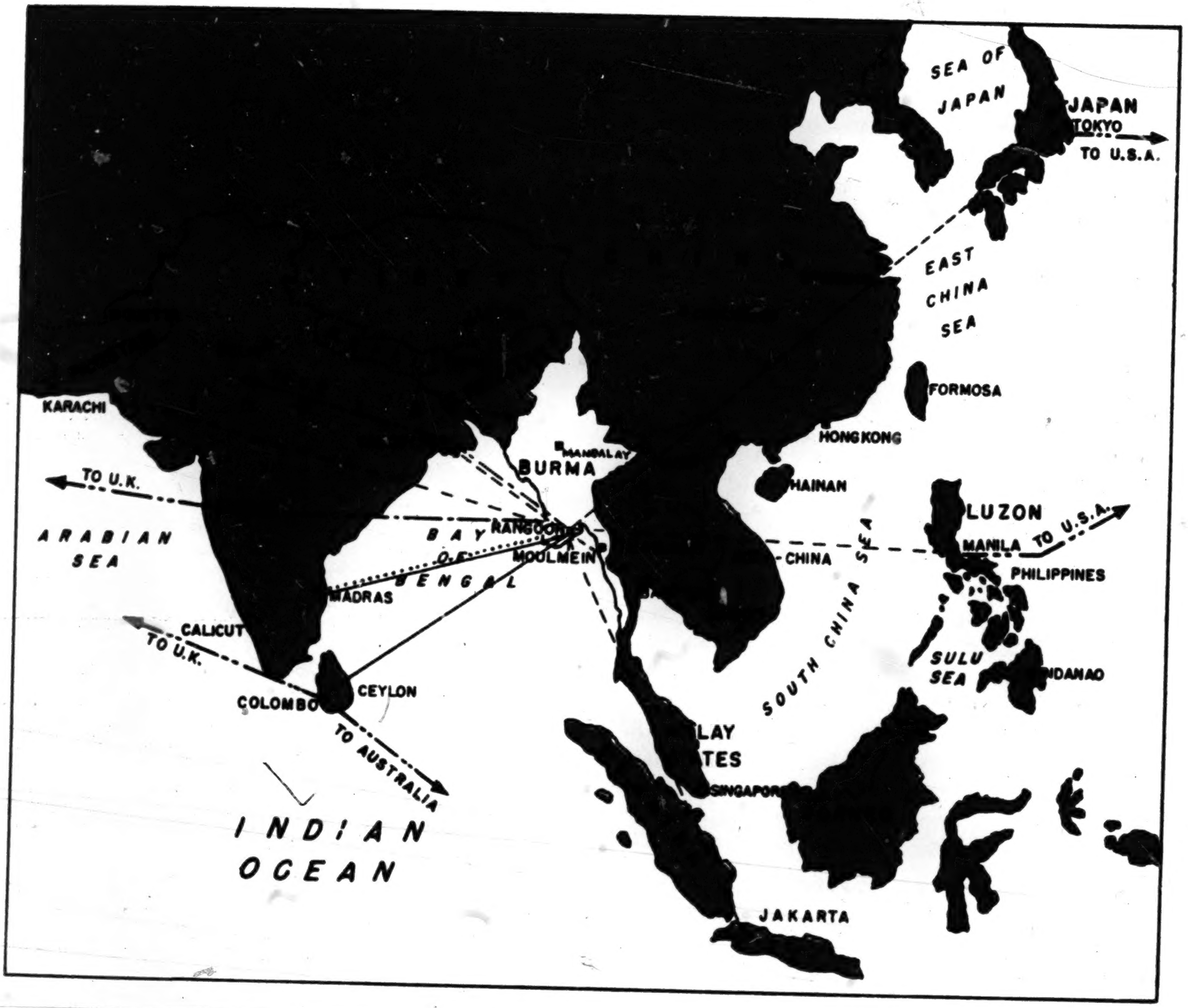
Once the Burma–India link is in operation, pressure will be felt for connections with other countries. Indonesia, Japan, Malaya and the Phillipine Republic use SSSC in their overseas telephone services. It would be a simple matter, at least from the technical point of view, to "hook-up" with them if Burma possessed a similar equipment. This point is made because it is feasible to use the same equipment for working some, or all, of these countries on part-time schedules until growth requires full-time service. Plate 2, an outline map of Burma and her neighbours, shows the route of this projected radiotelephone circuit as well as other desirable circuits.

(7) Other Essential Elements

The receivers and transmitters of this service would be located at the centers, and would be attended by the regular shift engineers. Connections to the telephone exchange would be through the same medium, v.h.f. radio or wire, as the telegraph circuits. Directional antennas for day and night frequencies are necessary for optimum performance of overseas radiotelephone circuits. Connecting high-frequency radio circuits to landline systems always raises problems. The instability of the radio link is responsible for most of the difficulty and makes it essential to employ rather elaborate equipment for a satisfactory junction. The radiotelephone terminal equipment has all of the facilities required to make the circuit operative in only one direction at any one instant. It also controls signal levels in both directions, filters out line noises, and by the privacy system, renders speech unintelligible to unauthorized listeners. It follows that a skilled operator is required at the controls of this terminal equipment.

(8) Estimate of Costs

In compiling the following figures, cognizance has been taken of the fact that this service will share certain Rangoon facilities with other communications services. Therefore against such items as land, buildings, connections to the central office and auxiliary power supply, there will be shown only a proportionate amount as chargeable to the proposed project.


SEA OF JAPAN
JAPAN
TOKYO
TO U.S.A.
EAST CHINA SEA
FORMOSA
KARACHI
MANDALAY
BURMA
HONGKONG
HAINAN
TO U.K.
LUZON
ARABIAN SEA
BAY OF BENGAL
RANGOON
MOULMEIN
CHINA
MANILA
TO U.S.A.
PHILIPPINES
MADRAS
SOUTH CHINA SEA
CALICUT
TO U.K.
SULU SEA
NDANAO
COLOMBO
CEYLON
LAY
TES
TO AUSTRALIA
SINGAPOR
INDIAN OCEAN
JAKARTA

Proposed Radiotelephone Link	………………
Alternate Radiotelephone Proposal	—·—·—·—
Active Radiotelegraph Circuit	————
Desirable Future Radiotelephone And/Or Radiotelegraph Links	– – – – – –
Connecting Radiotelephone And Radiotelegraph Circuits	—··—··—

MINISTRY OF NATIONAL PLANNING

RADIOTELEPHONE AND TELEGRAPH ROUTES

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. DATE PLATE
CK. BY. MAY 53 NO. 2

(a) Capital investment

Item	Life (years)	Foreign Exchange (kyats)	Local (kyats)
1. Transmitter	15	1,50,000	
2. Receivers	15	70,000	
3. Terminal and Privacy Equipment	15	45,000	
4. Connections to Exchange	15	65,000	
5. Emergency Power Supply	15	16,000	
6. Transmitting Antennas	5	10,000	8,000
7. Receiving Antennas	5	5,000	4,000
8. Housing (Radio and Power)	25		30,000
9. Sites for Buildings and Antennas			40,000
		3,61,000	82,000
Engineering and Contingency (10%)		36,100	8,200
		3,97,100	90,200
Total Capital Investment		K4,87,300	

It is reasonable to expect items 1–5 to render service for 15 years or possibly longer, if operated and maintained properly. An antenna life (items 6–7) of five years appears to be a low estimate, but was so chosen to permit the changes that are often necessary for expanding transmitting and receiving center operations.

(b) Annual costs. The annual cost of this service is comprised of (i) the annual investment charge of interest and amortization, (ii) maintenance and operation costs and (iii) administration costs.

(i) *Annual Investment Charge*

Items	*Amount (kyats)*	*Rate (%)*	*Annual Investment Charge (kyats)*	
1–5	3,46,000	9·634	33,333.64	
6 and 7	15,000	23·098	3,464.70	
6 and 7	12,000	22·463	2,695.56	
8	30,000	6·401	1,920.30	
				41,414.20

(ii) *Maintenance and Operation Costs*

Items	*Amount (kyats)*	*Rate (%)*	*Maintenance and Operation (kyats)*	
1–5	3,46,000	10·00	34,600	
6 and 7	27,000	5·00	1,350	
8	30,000	5·00	1,500	
				37,450.00

(iii) *Administration Costs*

Items	*Amount (kyats)*	*Rate (%)*	*Administration (kyats)*	
1–9	4,87,300	5·00	24,365	
				24,365.00
Total Annual Costs				K1,03,229.20

The administration charge may appear to be low. However, this project will be a small operation among the many activities of Telecommunications, and should carry only its proportionate percentage of the department's overhead.

(9) Service Charge to the Public

Besides indicating the order of yearly expenditure required to operate this radiophone system, the above estimate permits an approximate unit service charge to be computed. For example, it is believed that the maximum number of calls that the system could handle might reach 200, over an 18-hour day. This figure takes into consideration the time required for "person-to-person" arrangements as required by most overseas calls. However, it is unlikely that the saturation point of the system would be reached for several years. The local expense is the same for all calls regardless of destination; so a direct compilation of Burma's minimum fee can be made for various daily totals.

Calls per day	*Burma's local charge per call*
20	K14.10
50	K5.65
100	K2.85

In computing the cost of a trans-ocean call, it is necessary to add the local charges (as shown above) and applicable taxes to those of the foreign agencies. When agreements are made between telecommunications agencies of the various countries, flat rates are usually assigned to ordinary types of service. This facilitates the rapid and accurate compilation of costs on the standard "three-minute plus overtime" basis.

(10) Using the International Radiotelephone Service

In operation, the overseas telephone is little different from an ordinary long-distance landline system. A typical call would be handled in the following manner: a Rangoon subscriber wishing to converse with an associate in India, would simply call the telephone exchange and ask for the overseas operator. When connected, the operator records the particulars for reaching the desired party, and the caller disconnects. When the overseas operator has reached the desired individual over the radio link and foreign telephone system, she calls the subscriber back through the local exchange. The conversation then proceeds in the normal manner. During the talking period, the overseas operator has an opportunity to fill out the necessary toll ticket so that an accurate billing can be made. It is, of course, possible to have arrangements for several calls to proceed at the same time. Operators, with practice, become very proficient in handling these circuits.

Trans-oceanic radiotelephone services have been in operation all over the world for many years. Excellent relaying and interconnecting agreements permit calls to be made between most countries today, and at charges becoming increasingly reasonable as facilities are added and modernized.

g. Landlines to Other Countries

Because of the low traffic totals involved and the expense of maintenance through difficult border country, landlines between Burma and her neighbors cannot be justified in the foreseeable future. High-frequency radio can provide the traffic capacity and the required reliability at a fraction of line costs, once Telecommunications puts its radio operations on a modern commercial basis.

h. Rangoon Radio-station Centers

(1) General

In sizable radiotelegraph and radiotelephone operations, it is standard commercial practice to concentrate all activities in specialized areas. These are known as the Transmitter Center (TC), Receiving Center (RC), and Central Telegraph Office (CTO), respectively. Great efficiency in the utilization of manpower and machines is possible if these centers are correctly designed and adequately equipped. The Telecommunications Department has not achieved much in these respects because of the small, badly located areas available for receiver and transmitter centres.

(a) Antennas. Directional antennas are essential for optimum h.f. performance (both transmitting and receiving), but unfortunately require considerable land area. Receiving is further complicated by the multiple (two or three) well-spaced antennas required for diversity working. However, provided that the frequency and direction of the array is appropriate, several receivers may operate from one antenna. Antennas located some distance from the equipment are connected by untuned transmission lines of the correct impedance for optimum energy transfer. The layout of both types of centers deserves first-class engineering.

(b) Other requirements. Engineers, operators and technicians are usually employed on rotating shifts so that the advantages of working during certain hours can accrue to all hands in turn. Quarters, at least for key personnel, within the immediate neighborhood are highly desirable. Electricity, water and sanitation facilities are necessary for quarters as well as for the station proper.

(2) Planning

(a) Layout. On a large-scale map of the plot, antennas and station can be laid out to meet the present and future requirements for foreign and domestic circuits and equipment. From this information, clearing, leveling and road and powerline construction can be accurately laid out, and provisions made for water and sanitation. High-frequency operation does not require the low-resistance ground connection so essential to low-frequency equipment.

(b) Transmission lines. It should be kept in mind that untuned transmission lines are to be used, and arrangements made for all transmitters (and receivers) to work into the same value of impedance. Only in this way can the maximum flexibility be achieved. Because of negligible radiation of properly constructed and terminated lines, small, well-shielded transmitters can be stacked without harmful interaction.

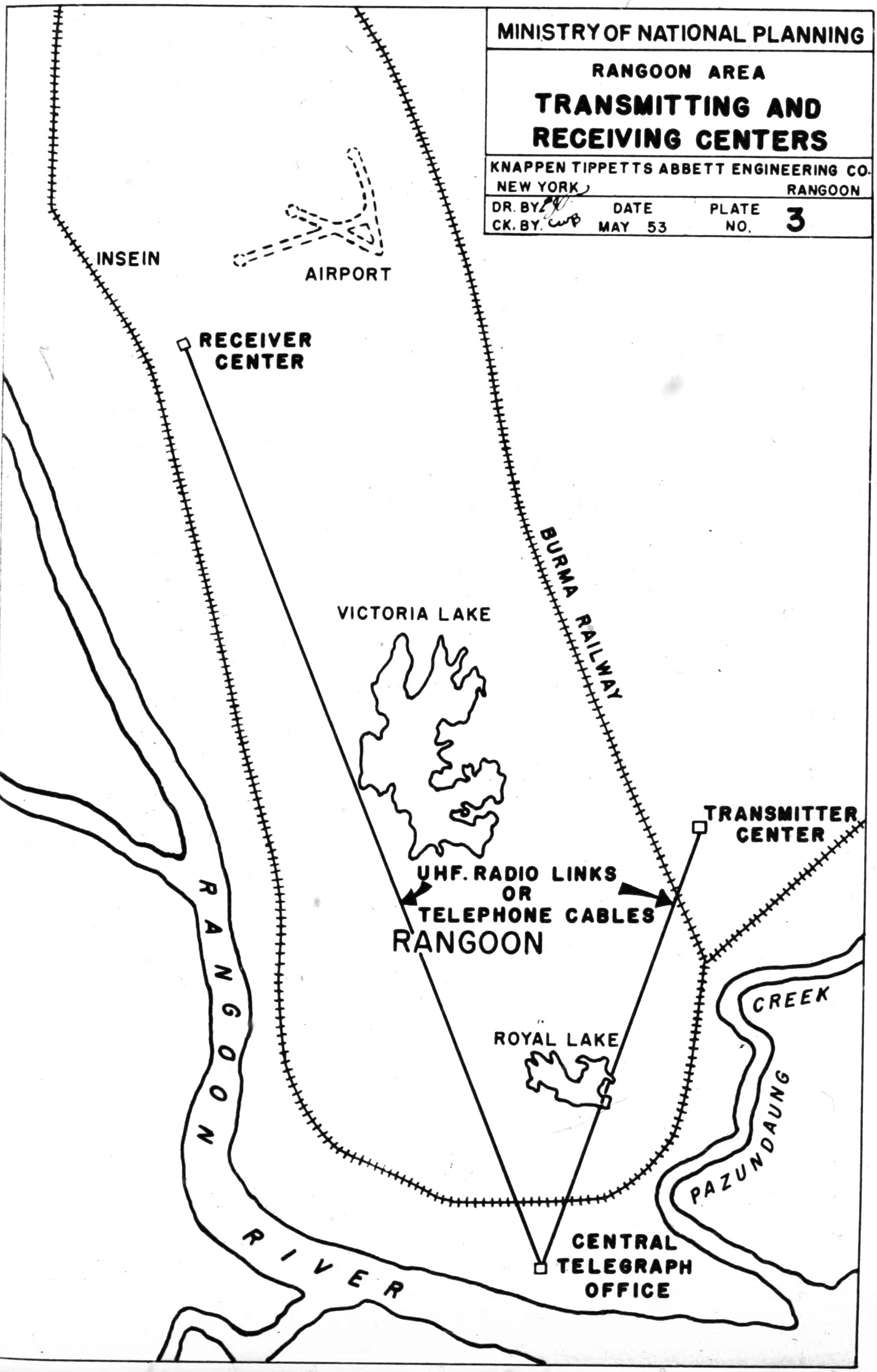
(c) Buildings. The station buildings required at the transmitting and receiving sites do not have to be unduly large, but they must be extremely functional. A small shop for limited maintenance, calibration and adjustment is essential, as well as adequate storage facilities for the most essential spares. Since the amount of clerical routine handled by the engineer in charge is negligible, a small office will suffice. A locker room with the usual facilities must be provided for staff convenience.

(d) Emergency power. The highest importance must be attached to the ability of these centers to function at all times. Consequently, emergency power supplies in the form of diesel-driven three-phase alternators must be ready at a moment's notice to take over the station load of lights and power from the commercial mains. Adequate housing for these machines as well as transmission and switch-over facilities must be included at each site.

(e) Center control board. At the receiver center, all signals must pass through the control board to the CTO by cable or radio. Since the order circuit between the two points also terminates at this board, any complaint involving signal level or quality can be resolved without delay or inconvenience. At the transmitting center, the keyed impulses from the CTO are distributed to the transmitters through a similar board which includes patching, ordering and monitoring facilities. For possible emergency operation, it is advisable to provide separate order and traffic-handling circuits.

(3) Connection to Central Telegraph Office

Plate 3 illustrates the physical relationship of the desired radio-station centers and the Central Telegraph Office. The distance from the CTO is not of much importance provided that it does not exceed eight to ten miles, but the transmitting and receiving centers should be as widely separated (three to five miles) as possible to attenuate interference. For connecting these areas to the CTO, there are two possibilities: telephone cable or v.h.f. radio. The trend in most countries is to utilize radio since it has considerable channel expansion properties, and facilitates connecting to the CTO without the hardships associated with laying and maintaining cable. In this particular instance, the first cost, convenience and reliability are slightly in favor of radio.



MINISTRY OF NATIONAL PLANNING

RANGOON AREA

TRANSMITTING AND RECEIVING CENTERS

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY
CK. BY. CWB
DATE MAY 53
PLATE NO. 3

INSEIN
AIRPORT
RECEIVER CENTER
BURMA RAILWAY
VICTORIA LAKE
TRANSMITTER CENTER
UHF. RADIO LINKS OR TELEPHONE CABLES
RANGOON
CREEK
ROYAL LAKE
PAZUNDAUNG
RANGOON RIVER
CENTRAL TELEGRAPH OFFICE

(4) Cost Estimate

These centers, as mentioned previously, will be the Rangoon terminals of foreign and domestic radiotelegraph and radiotelephone circuits. Their cost, maintenance and operation will be absorbed in these operations. However, it is necessary to estimate these figures to determine the order of expenditure required.

(a) Capital cost

*Item**	*Life (years)*	*Foreign Exchange (kyats)*	*Local (kyats)*
1. Transmitters	15	50,000	
2. Receivers	15	2,15,000	
3. UHF/VHF Traffic and Order Circuits	15	2,50,000	1,00,000
4. Antennas, Masts and Lines	15	1,25,000	
5. Emergency Power Supplies	15	1,00,000	
6. Housing (Stations and Quarters)	30		6,00,000
7. Roads	30		60,000
8. Sites	—		4,00,000
		7,40,000	11,60,000
Engineering and Contingency (10%)		74,000	1,16,000
		8,14,000	12,76,000
Total		K20,90,000	

* Does not include equipment for International Radiotelephone Link, nor any expansion of present radiotelegraph program, but replaces some outmoded military gear.

(b) Annual cost. The annual cost is comprised of: (i) the annual investment charge of interest amortization; (ii) maintenance and operating costs; and (iii) administration costs.

(i) *Annual Investment Charges*

Item	*Amount (kyats)*	*Rate (%)*	*Charge (kyats)*	
1–5	8,14,000	9·634	78,420.76	
4	1,10,000	8·994	9,893.40	
6, 7	11,66,000	5·783	67,429.78	
				1,55,743.94

(ii) *Maintenance and Operating Costs*

Item	*Amount (kyats)*	*Rate (%)*	*Charge (kyats)*	
1–3	5,66,500	10·0	56,650	
4–8	15,23,500	5·0	76,175	
				1,32,825.00

(iii) *Administration Costs*

Item	*Amount (kyats)*	*Rate (%)*	*Charge (kyats)*	
1–8	20,90,000	10·0	2,09,000	
				2,09,000.00
Total Annual Costs				K4,97,568.94

(5) Difficulty in Obtaining Sites

At this writing the transmitter center site is said to have been obtained, but the receiving site has become an item to be settled between the Ministries of Transport and Communications, and Agriculture and Forests. Since 1948 Telecommunications has been selecting and requesting various sites but always has had to yield to prior claim. The point has now been reached where service must be curtailed unless land for commercially acceptable centers is forthcoming. Owing to the location of the new Burma Broadcasting Service high-frequency transmitters, very little latitude for compromise in the location of a receiving center site remains.

i. Recommendations

(1) Radiotelephone and Telegraph

In connection with facilities discussed in this section, Burma's Foreign Communications Circuits, it is recommended that:

(*a*) Telecommunications arrange to operate the foreign radiotelegraph circuits with frequency-shift keying and teleprinter.

(*b*) Modern diversity receivers be used on these circuits.

(*c*) The Telecommunications administrations of neighboring countries, other than Ceylon and India, be contacted in the matter of split-schedule operation for handling mutual traffic to provide better relay facilities than now exist.

(*d*) Burma reopen immediately telecommunications matters with India, and arrange a high-level conference for an "across the table" exploration of the mutual advantage of the following:

(i) Adopting Single Sideband Suppressed Carrier (A3a) or Independent Sideband (A3b) for radiotelephone operation, and eventually a combined telephone-telegraph service. The use of ISB operation with two active telephone channels, one for Indian calls and the other for relayed calls, should be considered.

(ii) Allocating definite frequencies to this Burma–India telephone service so that they can be quoted in any further discussions, specifications or plans.

(iii) Improved high-speed (automatic Morse) operation at both ends of the present radiotelegraph circuit until (*a*) can be implemented.

(iv) Possible use of Calcutta as a telephone and/or telegraph terminal for working with Burma.

(v) Establishing flat rates for telephone landlines when used for mutual overseas calls.

(vi) Operation of the proposed radiotelephone service over an 18-hour day (minimum) to permit relays to Europe, Africa, and the western hemisphere reaching their destinations at a reasonable time of day.

(*e*) Telecommunications draft a complete specification of a modern, adequate AM radiotelephone transmitter, receiver and terminal to operate over the Rangoon–Madras Circuit, for distribution to manufacturers in the event that India will not go to SSSC. This is preferable to attempting a selection from the apparatus suggested in response to the previous request.

(*f*) Recognition be given to the fact that adequate radiotelephone and radiotelegraph equipment for foreign and domestic services will be required for the foreseeable future. Since the absolute necessity for proper sites has gone unrecognized too long and at the expense of the radio services of Burma, it is recommended that:

(i) The chosen receiving site, near Insein, be turned over to Telecommunications at once.

(ii) That Telecommunications proceed with plans for the centers and implementation thereof, as outlined in this report.

(iii) That u.h.f. radio circuits be used for traffic channels between the centers and the CTO, and v.h.f. be used for order circuits.

2. BURMA'S DOMESTIC COMMUNICATIONS

a. General

It is apparent that Burma's greatest single communications need is for better interior coverage utilizing all three media, telephone, telegraph and radio, to maintain a reasonable balance between need, service and costs. This was the partially realized objective of reconstruction after World War II, when the insurrection brought new problems with disastrous effects on the internal communications services.

Provisions must now be made for an adequate trunk-circuit pattern of interconnected community telephone exchanges and for essential telegraph facilities throughout the country. How and when this can be achieved may have far-reaching implications.

b. High-frequency Radio Scheme

(1) Details of the Plan

To meet the emergency brought about by the disruption of landline operation, Telecommunications developed a plan for telegraphic service utilizing high-frequency radio. This scheme required that the division headquarters stations should relay to Rangoon from a network of district stations. These, in turn, would work to and from their respective townships and villages. In all, some 250 radio stations were considered necessary under this plan. When the plans was made (1949–50), several stations were already working in a limited network. For essential government and public telegrams, the service was satisfactory and expansion along the same lines appeared feasible. In this connection, it may be stated that h.f. radio has no peer for medium–long distances, especially where the terrain is difficult, or the population hostile. There will therefore continue to be a well-defined, if decreasing, need for this medium in Burma.

(2) Disadvantages

The serious disadvantages and drawbacks of placing a nation's intercommunity communications into large scale h.f. operation should be evaluated in terms of a peace-time commercial communications service. At best, each h.f. circuit can carry but one telephone and one telegraph channel without unrealistic expenditure. Also the portion of the radio frequency spectrum from 3,000 to 30,000 KC (classified as h.f.) is best suited to long-distance communications, and has been reserved for that purpose (Chapter III, Article 7 of the ITU Code) by the International Telecommunications Union, of which Burma is a member. With all nations clamoring for more h.f. channel authorization, and with a sizable block of countries refusing to honor international allocations, the band is extremely crowded. Random or consistent interference and fading hinders operations which are also subject to deterioration during heavy atmospherics, especially those prevalent at the beginning and end of the monsoon season. There are no inexpensive means of insuring secrecy on these circuits. As presently operated, any station within range (which may be a considerable distance under favorable conditions) can tune in and copy. Monitoring or jamming by unfriendly elements is simple. No nation in modern communications history has ever limited its civil facilities by committing itself to large scale h.f. operation for its primary internal communications net.

With h.f. radiotelegraph (W/T) stations manually operated on discontinuous schedules and working in small nets, several relays (and delays) may be necessary before a message is delivered. As the number of stations increases these situations multiply. Consequently, the service cannot be regarded as fast, nor entirely dependable. It is also extremely expensive.

(3) Estimated Cost (per station)

(a) Capital costs

Item	*Life (years)*	*Foreign Exchange (kyats)*	*Local (kyats)*
1. Transmitters and Receivers	15	15,000	
2. Power Supplies	15	5,000	
3. Antennas, Tools and Incidentals	15	1,000	
4. Accomodations (site, station, quarters)	30		80,000
		21,000	80,000
Total		K1,01,000	

(b) Annual costs (per station). The annual costs include (i) the interest and amortization on the investment, (ii) maintenance and operating costs and (iii) administration costs.

(i) *Annual Investment Charges*

Item	*Amount (kyats)*	*Rate (%)*	*Charge (kyats)*	
1–3	21,000	9·634	2,023.14	
4	80,000	5·783	4,626.40	
				6,649.54

(ii) *Maintenance and Operating Costs*

Item	*Amount (kyats)*	*Rate (%)*	*Charge (kyats)*	
1–3	21,000	70·00	14,700	
4	80,000	5·00	4,000	
				18,700.00

(iii) *Administration Costs*

Item	*Amount (kyats)*	*Rate (%)*	*Charge (kyats)*	
1–4	1,01,000	10·00	10,100	
				10,100.00
Annual Costs (per station)				K35,449.54

(c) Conclusions. The establishment and operation of a radiotelegraph station as Telecommunications has planned is an expensive venture. The impact of the "Accomodations" figure (item 4) on the expenditure can be softened considerably by continuing the policy of renting station and quarters, but at the expense of risk to equipment, staff discontent and half-hearted application to the job at hand. Under "Administration" are included central engineering and office overhead.

According to this estimate, it will cost Burma about K88 lakhs per year to operate a system of 250 radio stations in a telegraph network on the scale which Telecommunications has suggested. It is estimated further that, if telephone facilities for working through local exchanges were added to this network, the cost would be at least doubled. The poor results obtained on an experimental radiotelephone circuit between Rangoon and Moulmein during the past few months are considered indicative of what can be expected of a low-power h.f. radiotelephone program.

(4) Manpower Requirements

For a system of 250 radio stations, the manpower needs are imposing, especially the number of trained technicians required.

Title	*Manpower Requirements*	
	Per Station	*For 250 Stations*
Supervisor	1	250
Operator	2	500
Engine-driver	1	250
Peon	1	250
Durwan	1	250
Sweeper	1	250
Total	7	1,750

To meet the vacancies occurring through natural turnover, leaves, retirements and other causes, it is essential that a minimum reserve of two hundred men be available for the several categories. The personnel problems inherent in a staff of this size, far-flung in location, are diverse and must be handled with skill and consideration. Adequate housing for staff and station will eliminate most major complaints.

(5) Domestic Telegraph Revenue

In round figures, the inland telegraph system earned K9 lakhs in 1950–51, and somewhat more in 1951–52, but not enough to cover operating expenses. It is possible to forecast with reasonable accuracy that the domestic telegraph deficit will increase because the larger municipalities, which are the most lucrative sources of business and which have been radio-equipped for some time, are already included in the revenue returns. Smaller district stations cannot pay their way even with drastic compromises in service, quarters and staff.

(6) Service to be Expected

Because of the basic sociological and economic importance of a reliable communications system, a reasonable operating deficit can be written off, especially if the service is entirely satisfactory. In this instance the service cannot be expected to become wholly satisfactory. Instances are frequent of messages requiring 24 to 72 hours to reach their destinations in towns having radiotelegraphic services in this relatively small system of 60-odd stations. As the number of stations is increased there is reason to believe that service will deteriorate further. Relaying from net to net is closely akin to the transfer operation currently found so objectionable in the Rangoon telephone system. Operation on the basis of a continuous watch permitting direct traffic handling on demand (as in the maritime services) would not be feasible because of the equipment, manpower and frequency requirements. The conclusion is inescapable that if high-frequency radio has a place in Burma's telecommunications pattern that place is limited to long-haul circuits to isolated outposts.

c. VHF and UHF (Microwave)

(1) General

Since their initial application in the early thirties u.h.f. and v.h.f. (ultra high frequency and very high frequency) have enjoyed increasing popularity among telecommunications administrations. Although these radio circuits are not in every case the best choice, there are enough situations in which one or the other is preferable to other media to warrant a careful study of their application to Burma's needs.

(2) VHF and UHF Described

The term Very High Frequency is applied to any radio system utilizing frequencies between the limits of 30 and 300 megacycles. As the frequency increases from the lower limit, the transmission characteristic of Heaviside layer reflection, good for long distance if somewhat inconsistent operation, changes rather abruptly to unreflected, quasi line-of-sight, and very consistent operation. The term Ultra High Frequency is applied to operation between 300 and 3,000 megacycles. The term Super High Frequency (s.h.f.) is applied to frequencies between 3,000 and 30,000 megacycles. The frequencies above 900 megacycles are referred to broadly as being in the microwave region. As the frequency increases the transmission characteristics more nearly approach those of the transmission of light. The signals can be concentrated with a simple antenna in much the same manner that a strong beam of light can be produced with a polished reflector. Intervening objects, such as buildings, hills, trees, etc., cast a shadow; that is, block the signal.

(3) Basic Differences, and Advantages over HF

The basic differences between the various categories are therefore matters of frequency and behavior, u.h.f. and s.h.f. requiring a line-of-sight path between stations, while v.h.f. is slightly more tolerant in this respect. These differences have a great bearing on the practical application of these radio systems. The higher the transmission frequency, the more channels it can accommodate. This offsets the disadvantage of shorter working distances. The greatest advantages of v.h.f., u.h.f. and s.h.f. over simple h.f. are the consistent, static-free signals, and the large number of channels (telephone or telegraph) that can be accommodated by one wide-band transmitter. Of course, the need for transmission lines or cables between stations is eliminated.

The situations under which advantages accrue, however, are quite inflexible and well defined—v.h.f., u.h.f. and s.h.f. are advantageous where:

(*a*) There is heavy, continuous traffic over long-haul circuits.

(*b*) Many telephone or telegraph channels are required.

(*c*) Continuous power can be assured at stations and repeaters.

(*d*) Highly competent technicians are available.

(*e*) Landline costs compare unfavorably; and landline maintenance is difficult.

(*f*) New operations are about to begin, or considerable expansion is accurately forecast.

(*g*) Private point-to-point connections are required for metering, signaling and special services.

(*h*) Landlines are insecure from sabotage and theft.

(4) Disadvantages

The disadvantages lie in the necessity for repeater stations at 20–30-mile intervals, and in the rather complex and expensive array of equipment required in each station, especially where one or more channels are dropped or introduced. This considerably narrows the applicability of these systems. To operate the equipment, a most reliable source of power with standby service for emergency is required. In the United States, where systems have been engineered to a high degree of reliability, most repeater stations are completely automatic and unattended. The adjustment and maintenance of this equipment is highly specialized and requires very competent technicians. In many parts of the world, these conditions are difficult to meet. Failures can be very costly.

(5) Considerations Affecting Burma's Needs for VHF and UHF

The population distribution in Burma is shown by the map, Population and Population Distribution, in Chapter I. Since a significant shift in the foreseeable future is quite unlikely, it is not difficult to decide where principal communications channels must be established. Because several of these areas are already served by the h.f. radiotelegraph system, it is possible to forecast somewhat accurately the order of ultimate telegraph traffic totals. The following spot checks are included to indicate the loading of these main circuits into Rangoon, the center of Burma's communications system:

Circuit	*Weekly Messages Sent*	*Average Received*
Rangoon–Delta	872	962
Rangoon–Moulmein and Tenasserim	760	969
Rangoon–Prome and Tharrawaddy	315	381
Rangoon–Akyab	375	774
Rangoon–Mandalay and N. Burma	2,483	2,710

It is estimated that, if trunk telephone service were widely available to compete for this business, these totals might be lower. For this reason they can be accepted for the present as saturation figures. None of these circuits can be considered heavily loaded, nor very remunerative. Consequently, telegraph facilities should be combined with those of other services to derive all economies possible. A telegraph channel can be operated on a telephone channel without difficulty. While there is not heavy continuous traffic, several channels (telephone and telegraph) are nevertheless required.

Outside of Rangoon, commercial power is not generally available on a 24-hour basis, but may be within the next few years. Generating power on a small scale for repeater stations is very expensive from the standpoints of fuel consumption, maintenance and supervision. Competent microwave technicians are not available in Burma, but there are some able h.f. trained personnel who can be upgraded in a short period of time. Line costs on the main traffic channels where existing right-of-way can be followed are not prohibitive in Burma. Maintenance in the face of sabotage and theft is extremely difficult, but could be improved immeasurably by sterner measures. Other elements of maintenance can be made less expensive and less annoying by improved methods to be discussed in paragraph E–2–d–(6)–(a).

The first phase of the internal communications rehabilitation program should be concerned with restoring prewar-postwar parity. New and expanded services belong properly in a later phase. Certain organizations could profitably use private or shared lines between Rangoon and other areas, and these needs should be determined and incorporated in future planning. The wide-band transmission potentialities of microwave systems can provide as many channels as Telecommunications can possibly need.

(6) Rangoon–Mandalay Circuit Possibilities

(a) Routes and "hops." There are two possible routes for communications between Burma's two largest cities. One follows the Pegu, Toungoo, Pyinmana, Thazi, Kyaukse main rail and highway route into Mandalay, while the other goes through Tharrawaddy, Prome and Chauk to Myingyan and thence to Mandalay. Local communications should be provided along these routes, and trunk channels picked up or dropped where necessary. On this basis a cost estimate for a multi-channel microwave system between Rangoon and Mandalay has been prepared. To insure that as many repeaters and stations as possible are located within towns for security and utility reasons, 22 "hops" are considered necessary.

(b) Capital cost

Item	*Life (years)*	*Foreign Exchange (kyats)*	*Local (kyats)*
1. Radio and Terminal Equipment	15	21,00,000	
2. Testing Equipment	15	1,00,000	
3. Power Source	15	3,50,000	
4. Antenna Towers	15	1,80,000	
5. Accomodations (Sites, Stations, Quarters)	30		17,85,000
		27,30,000	17,85,000
Engineering and Contingency (10%)		2,73,000	1,78,500
		30,03,000	19,63,500
Total		K49,66,500	

(c) Annual costs. The annual costs include (i) the annual investment charges, (ii) maintenance and operating costs, and (iii) administration costs.

(i) *Annual Investment Charges*

Item	*Amount (kyats)*	*Rate (%)*	*Charge (kyats)*	
1–4	30,03,000	9·634	2,89,309	
5	19,63,500	5·783	1,13,450	
				4,02,759

(ii) *Maintenance and Operating Costs*

Item	*Amount (kyats)*	*Rate (%)*	*Charge (kyats)*	
1–4	30,03,000	10·0	3,00,300	
5	19,63,500	5·0	98,175	
				3,98,475

(iii) *Administration Costs*

Item	*Amount (kyats)*	*Rate (%)*	*Charge (kyats)*	
1–5	49,66,500	10·0	4,96,650	
				4,96,650
Total Annual Cost				K12,97,884

To serve the two main routes, as previously described, another circuit similar in design and cost would be necessary. Thus the estimated annual cost for the Rangoon–Mandalay and intermediate trunk channels is K26 lakhs, or roughly K3,250 per system mile. If ten channels were used, this would cost K32.50 per channel mile.

(7) Rangoon–Delta Possibilities

(a) General. The terrain of this area seems extremely well suited to the application of u.h.f. for trunk circuits. Not only are "blocking" hills conspicuously absent, but the large number of cable river-crossings to be eliminated makes the whole idea additionally attractive. Also, populated centers occur at strategic points for relay stations.

(b) Present utilization. During the reconstruction period after World War II, Telecommunications decided to try out v.h.f. in this difficult (for landlines) area. As a consequence, a circuit to connect Bassein and Rangoon via Wakema and Maubin was designed, and the equipment contract was placed with General Electric Company. Simultaneously, an order was placed for Rangoon–Moulmein "single-hop" circuit equipment.

(1) *Circuit Details*

(*a*) *Channel facilities.* At the time these circuits were planned, 1949, although combination telephone-telegraph multiple-channel operation may have been considered, single-channel working between Rangoon and Bassein was specified. Later, drop-off facilities for Wakema and Maubin were ordered. In brief, the circuit can handle but one conversation at a time (equivalent to a pair of wires), with terminations in each of the four centers.

(*b*) *Equipment details.* Frequencies between 66 and 86 megacycles were selected for this operation. The phase-modulated transmitters can deliver ten watts into three-element directional antennas. The receivers are of the conventional superheterodyne, limiter-discriminator type. This equipment is capable of high-quality voice-circuit operation.

(*c*) *Antenna masts.* The equipment arrived in Rangoon in mid-1951, and reposed in the stores' godown until early 1953, when installation was begun. The failure to order appropriate antenna masts with the equipment contributed to this long delay. The masts are much larger and heavier than necessary for this application, but can carry other antennas besides those for v.h.f. working.

(2) *Installation and Operation.*

The Rangoon–Maubin leg has begun two-way operation, but the circuit is not yet on a commercial basis. There is no reason to believe that the system will be other than satisfactory. However, the extent of degradation in the speech circuit from noise in the repeaters is not yet known. The lack of 24-hour commercial electricity outside of Rangoon handicaps the operation of all electronic equipment.

(3) *Rangoon–Moulmein Circuit*

The choice of 32 and 35·5 MC frequencies would seem to preclude commercial quality 24-hour operation over this 90-mile circuit. During certain times of the day, for brief periods of the year, satisfactory operation may be possible. At other times, the circuit will be unreliable. It therefore offers little or no improvement over the present h.f. circuit.

(4) *Cost*

The total figure will probably exceed K5 lakhs, not including housing. A rough computation of the annual costs (Rangoon–Bassein circuit), based on this figure, follows:

Category	*Rate*	*Charge*
Investment (15-year life)	9·634	48,170
Operation and Maintenance	12·5	62,500
Administration	10·0	50,000
Total Annual Cost		K1,60,670

or 1,60,670/98 = K1,640 per circuit mile.

(c) UHF study

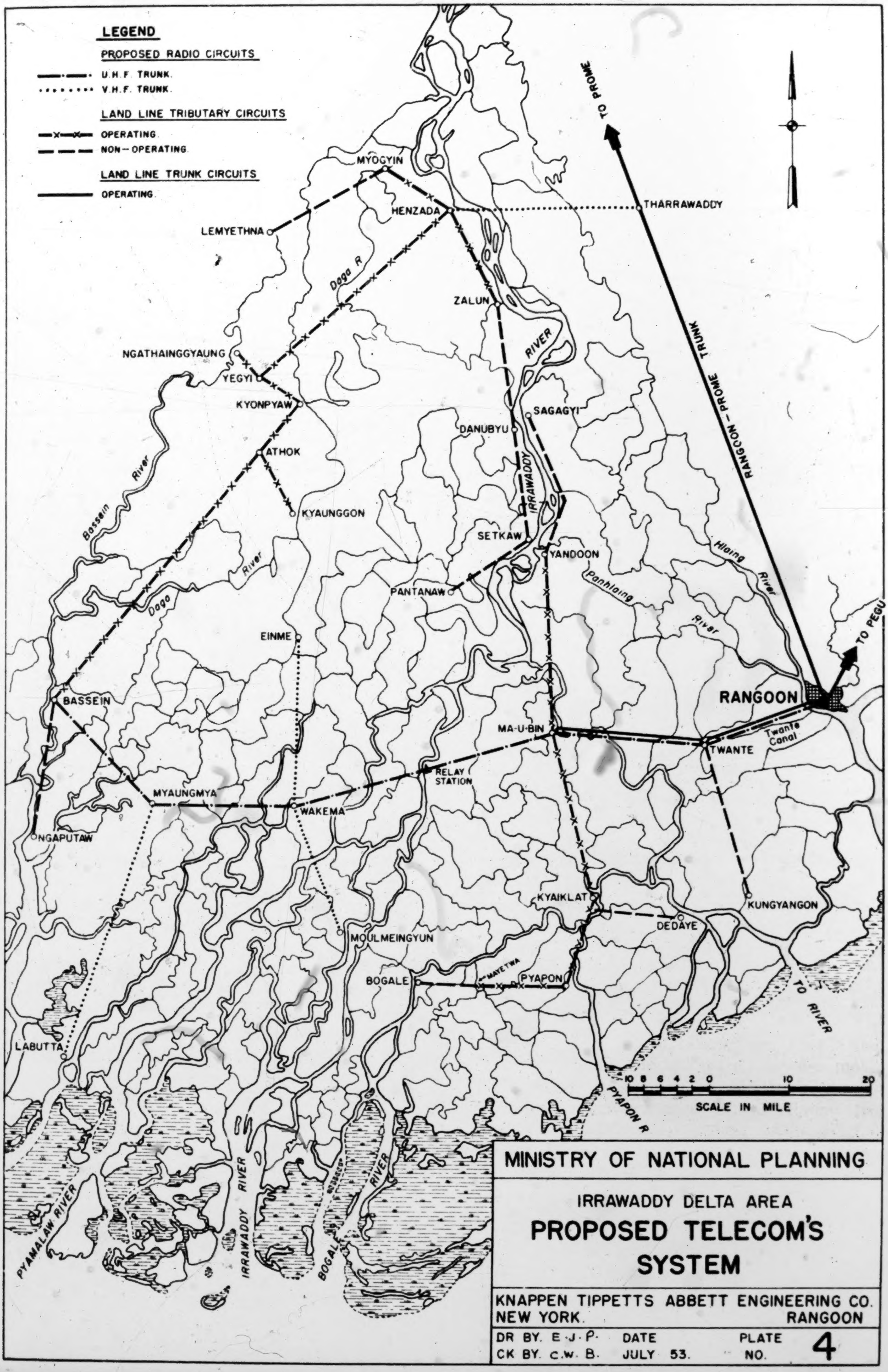
(1) *General*

As the Delta is the most promising area in all Burma for v.h.f./u.h.f. trunk-circuit application, it was decided to determine the approximate cost of a modern microwave multi-channel system. With telegraph and telephone channels from each toll center to Rangoon, and with intervening local circuits, the economic picture becomes much brighter than that of the v.h.f. system.

(2) *Communities Served*

To provide maximum service, and to maintain short reliable hops, Myaungmya and Twante were added to the Bassein–Rangoon path. One relay station is deemed necessary midway between Wakema and Maubin. All hops are less than 20 miles so that reflector tower heights are kept within modest limits. Exclusive of Rangoon, the total population (five towns) served directly would be more than 150,000. Tributary lines (landline and v.h.f.) connecting several towns to the toll centers would increase this figure considerably.

(*a*) *Channels required.* Cursory checks indicate that while there is some traffic between these communities, most traffic would be to and from Rangoon. Therefore one through telephone and one through telegraph circuit are considered adequate for each center's needs. In addition, local working between adjacent points is also included. One spare telephone circuit could be maintained from Bassein to Rangoon. In all, seven telephone and seven telegraph channels would be provided initially.


LEGEND
PROPOSED RADIO CIRCUITS
U.H.F. TRUNK.
V.H.F. TRUNK.
LAND LINE TRIBUTARY CIRCUITS
OPERATING.
NON-OPERATING.
LAND LINE TRUNK CIRCUITS
OPERATING.
TO PROME
MYOGYIN
HENZADA
THARRAWADDY
LEMYETHNA
Daga R
ZALUN
RIVER
NGATHAINGGYAUNG
YEGYI
KYONPYAW
SAGAGYI
DANUBYU
RANGOON-PROME TRUNK
ATHOK
IRRAWADDY
KYAUNGGON
Bassein River
SETKAW
YANDOON
Daga River
PANTANAW
Panhlaing River
Hlaing River
TO PEGU
EINME
RANGOON
BASSEIN
MA-U-BIN
TWANTE
Twante Canal
RELAY STATION
MYAUNGMYA
WAKEMA
NGAPUTAW
KYAIKLAT
KUNGYANGON
DEDAYE
MOULMEINGYUN
BOGALE
MAYETWA
PYAPON
TO RIVER
LABUTTA
10 8 6 4 2 0 10 20
SCALE IN MILE
PYAPON R
PYAMALAW RIVER
IRRAWADDY RIVER
BOGALE RIVER

MINISTRY OF NATIONAL PLANNING

IRRAWADDY DELTA AREA

PROPOSED TELECOM'S SYSTEM

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK. RANGOON

DR BY. E.J.P. DATE PLATE
CK BY. C.W.B. JULY 53. NO. 4

(3) *Cost Estimate*

(*a*) *Capital investment*

Item	*Life (years)*	*Foreign Exchange (kyats)*	*Local (kyats)*
1. Radio and Terminal Equipment	15	7,00,000	
2. Test Equipment	15	35,000	
3. Power Source	15	1,10,000	
4. Antenna Towers	15	60,000	
5. Accomodations (Sites, Station Buildings, Quarters)	30		6,00,000
		9,05,000	6,00,000
Engineering and Contingency (10%)		90,500	60,000
		9,95,500	6,60,000
Total		K16,55,500	

(*b*) *Annual costs*

(i) *Annual Investment Charges*

Item	*Amount (kyats)*	*Rate (%)*		*Charge (kyats)*
1–4	9,95,500	9·634	95,816.47	
5	6,60,000	5·783	38,167.80	
				1,33,984.27

(ii) *Maintenance and Operating Costs*

Item	*Amount (kyats)*	*Rate (%)*		*Charge (kyats)*
1–4	9,95,500	10·0	99,550	
5	6,60,000	5·0	33,000	
				1,32,550.00

(iii) *Administration Costs*

Item	*Amount (kyats)*	*Rate (%)*		*Charge (kyats)*
1–5	16,55,500	10·0	1,65,550	
				1,65,550.00
Total Annual Cost				K4,32,084.27

The estimated annual cost is approximately K4,300 per system-mile or roughly K300 per channel-mile for all telephone and telegraph trunk operation.

(4) *System operation requirements*

(*a*) *General.* The estimate has been based on very high quality equipment to provide continuous reliable service. Competent maintenance personnel must be available. Operation of 6,000 MC equipment is not difficult, but is exacting. Complete standby equipment is furnished to eliminate lengthy circuit interruptions.

(*b*) *Security.* An interruption at any point kills the through circuits. Consequently the small building and modest tower installations must be amply protected in any such scheme.

(*c*) *Power.* Since reliable commercial power is not available outside of Rangoon, diesel-driven generators are required in duplicate at each location. Reserve capacity will supply lighting for the station and quarters.

(*d*) *Quarters.* Modest quarters are necessary to house the key technical staff near the station on an "on-call" basis.

(d) VHF tributary links

(1) *General*

When the multi-channel u.h.f. system outlined above replaces the Rangoon–Bassein single-channel v.h.f. circuit, the displaced equipment (three complete links) can be used to advantage on tributary circuits where river crossings complicate the maintenance of landlines.

(2) *Most Urgent Need*

As indicated on Plate 4, if a connection were provided between Henzada and Tharrawaddy, the landline system between Henzada and Bassein could work into the Rangoon–Prome landline trunk.

(*a*) *Equipment available.* Telecommunications has a complete two-way v.h.f. system which was purchased for experimental telephone service links. This equipment is designed for 12-volt operation on frequencies of 73 and 85 megacycles. It is suggested that these units could be installed to provide the Henzada–Tharrawaddy link described above. There is no power-supply problem because petrol-operated battery chargers are available locally. Antenna masts for this operation should be 75 to 100 feet high. The equipment already has telephone-exchange connection facilities.

(3) *Other Links*

(*a*) *Einme–Wakema–Moulmeingyun.* To put these circuits into operation will merely involve moving Bassein's v.h.f. equipment to Moulmeingyun and the proper receiver-transmitter to Einme from Maubin.

(*b*) *Myaungmya–Labutta.* It is proposed that this circuit will utilize the v.h.f. equipment no longer needed on the Maubin–Rangoon link.

(e) Conclusions. Microwave radio can provide very economical communications facilities where the channel demand is great enough. Experience with the v.h.f. limited trunk system in the Delta will be of great value in determining how widely this plan should be developed. Its installation in the Delta should be pushed. Elsewhere in Burma the landline situation must be assessed.

d. Trunk Landlines

(1) General

The greatest share of the world's trunk circuit operation is, and probably will continue to be handled over landlines. Easy to maintain, especially in climates without snow, ice and disastrous winds, a line properly constructed and cared for has an extremely long life, and is capable of very reliable service. The advent of vacuum-tube repeaters has permitted a substantial reduction in the size of conductors, and improved metallurgical techniques have provided stronger wires for longer spans. Consequently, greater economies than ever before are now possible in line construction.

(2) Multi-channel Operation

(a) Carrier current system. Since the carrier principle was first demonstrated, the trend has been towards the reduction of the number of lines required while still increasing the number of working channels. A carrier system can provide hundreds of channels, or can be used to superimpose but one channel on a telephone or telegraph line. There are many similarities between carrier-current systems and radio systems, the major differences being the frequencies normally used and the fact that the carrier-current signals are confined to metallic wire circuits instead of being radiated into space.

(b) Carrier requirements. Because of the increased electromagnetic and electrostatic coupling effects at carrier frequencies, special precautions must be taken in the design of carrier lines to prevent undesirable interaction between lines. Frequent transposition of each wire pair and rigid tolerances in support, tension and insulation of each conductor are required. Where but one carrier pair is a part of any alignment, considerable latitude may be taken in all matters except insulation. Well trained technicians are required for operation and maintenance of the terminal and repeater units, and a reliable source of power is necessary at these points.

(c) Radio *v.* landline carrier. Each has its advantages; so a choice must be dictated by the facts of the individual case. More channels can be accommodated on a u.h.f. radio circuit, a great advantage if the traffic warrants. The landline carrier has the advantage (by a ratio of 8 or 10 to 1) in the allowable distance between repeaters. Ordinary local operation between towns can be carried on over carrier lines without interaction. Simplex connections can also be utilized for an additional telegraph circuit.

(3) Landline Carrier in Burma

(a) Previous use. Landline carrier working is not new to Burma. Several carrier circuits proved their worth on the Rangoon–Prome and the Rangoon–Mandalay routes before World War II.

(b) Present equipment and facilities. Some of the Telecommunications engineering and operating staff have had experience with carrier working, and can serve as a nucleus for future activity of this nature. Recommendations have been made (Interim Report, page 279) that the present stock of new and used carrier equipment be inventoried, and put through an operational check. This work has not progressed beyond the inventory stage. Presently, equipment is stored in Rangoon, Toungoo and Mandalay.

(c) Planning. Had a carrier program been engineered and pushed, rehabilitation could have begun two years ago wherever security permitted. The headlong rush into h.f. radiotelegraphy as a communications medium seems to have channeled responsible thinking away from the absolute necessity for a landline system for certain functions. While much valuable time has been lost, it is not too late to look into this whole matter.

(d) Trunk routes. As mentioned previously, the concentration of population, industry and commerce favors several main telecommunications trunk routes. From toll centers, tributary primary and secondary lines can provide any degree of coverage desired, utilizing much of Burma's huge investment in line structures.

(1) *Rangoon–Mandalay via Pegu, Toungoo and Thazi*

This circuit needs to be repaired between Pyinmana and Yamethin to permit through working. It offers the earliest and easiest prospect for a carrier route between Burma's two largest cities.

(2) *Rangoon–Mandalay via Prome and Myingyan*

This circuit is in operation as far as Prome. The line was not designed for carrier operation, but there is evidence it would serve for the interim.

(3) *Rangoon–Moulmein via Pegu*

This circuit is broken between Waw and Mokpalin, also between Martaban and Moulmein (Salween River).

(4) *Rangoon–Delta*

Lines are in operation to Maubin through Twante. Other more remote points have been connected in the tributary network. The possibility of through operation to Bassein seems remote, and for this reliance will probably be placed on the v.h.f. radio system now being installed. Because of the numerous and wide river crossings and the general inundation of the countryside for a portion of the year, landline maintenance is expensive and difficult. Consequently, u.h.f. radio on the scale described seems the best answer to the problem of trunk operation in the Delta.

(5) *Mandalay–Lashio via Maymyo*

This circuit has been in operation for a considerable period of time. Traffic does not warrant carrier working at this time.

(6) *Mandalay–Myitkyina*

This circuit requires considerable rehabilitation and expansion. It is not likely that carrier working can be justified within the next few years.

(7) *Conclusions*

The two Rangoon–Mandalay circuits are ideally suited for carrier working. Much equipment and line facilities are available with which to begin the rehabilitation work (see succeeding paragraphs). All new construction of trunk-route lines (except in the Delta) should be to carrier standards against the time when such operation will be practical and necessary.

(4) Rangoon–Mandalay Circuit Estimates

(a) General. Three-channel carrier terminals with spares, in the original packings, are held in Telecommunications' stores. This equipment would permit three both-way circuits besides the normal voice and telegraph working, on one pair of wires. A small building to house the terminal equipment is required on the outskirts of Rangoon to eliminate the necessity of special overhead lines through the city to the trunk exchange. Unsatisfactory transmission of carrier frequencies over cable circuits without special equipment makes this necessary. Conventional cable connections will suffice from the terminal equipment to the trunk exchange.

(b) Cost estimates. Because rehabilitation of the carrier system has not been coordinated and kept current by frequent information from the districts, the accuracy of line rehabilitation figures is low. They are adequate, however, for budgetary and preliminary planning. Both trunks are calculated on the basis of providing two intermediate toll centers.

(1) *Capital Investment*

Item	*Life (years)*	*Foreign Exchange (kyats)*	*Local (kyats)*
1. Terminal Equipment	15	75,000	2,000
2. Repeater "	15	72,000	2,000
3. Filter "	15	40,000	1,000
4. Power Supplies	15	20,000	
5. Line Rehabilitation	30	9,00,000	4,00,000
6. Buildings	30		1,50,000
		11,07,000	5,55,000
Engineering and Contingency (10%)		1,10,700	55,500
		12,17,700	6,10,500
Total Estimated Cost		K18,28,200	

(2) *Annual Cost*

(i) *Annual Investment Charges*

Item	*Amount (kyats)*	*Rate (%)*	*Charge (kyats)*	
1–4	2,27,700	9·634	21,936.62	
5	9,90,000	6·505	64,399.50	
1–4	5,500	4·994	274.67	
5–6	6,05,000	5·783	34,987.15	
				1,21,597.94

(ii) *Maintenance and Operating Costs*

Item	*Amount (kyats)*	*Rate (%)*	*Charge (kyats)*	
1–4	2,33,200	10·0	23,320.00	
5	14,30,000	8·5	1,21,550.00	
6	1,65,000	5·0	82,500.00	
				2,27,370.00

(iii) *Administration Costs*

Item	*Amount (kyats)*	*Rate (%)*	*Charge (kyats)*	
1–6	18,28,200	10·0	1,82,820.00	
				1,82,820.00

Total Estimated Annual Cost K5,31,787.94

From this figure, the annual cost per system mile is estimated at roughly K670, or less than K170 per telephone-channel-mile.

(c) Cost comparison. As indicated in paragraph E–2–c–(6)–(c) the annual cost for u.h.f. trunks over the same routes is estimated at K3,250 per system mile, or K2,580 higher than landline carrier. If only one route was equipped with u.h.f., the balance would still favor landline trunks by K955 per system-mile. The larger potential channel expansion of u.h.f. is no advantage, in this case, because Burma's future requirements do not require it. A modest expansion of landline carrier can meet all foreseeable future needs.

(5) Carrier Line Material Reclamation

At the end of World War II, a carrier line was constructed from Tamu to Mandalay for military purposes. Because there is no longer a need for this type of line between these points, it has been suggested that the materials be removed and used for rehabilitating the Rangoon–Mandalay carrier circuits. While reliable information is meager, it is believed that enough material for at least a hundred miles of carrier line could be recovered. The matter merits close investigation from the standpoints of possible future need for this line, removal cost and general condition of the material.

(6) Trunk Service to Outlying Areas

(a) General. Once the primary trunks have been established the major proportion of the population is served. But, many secondary trunks and tributary circuits are necessary to provide some communications facilities for the remaining large areas. How extensive and appropriate the system becomes depends on the critical balance of cost, revenue and need. The accumulation of all the facts necessary for definite proposals in these areas is beyond the scope of the present survey. However, opinions based on personal visits to some of these areas and/or reliable information are expressed as conclusions in respect to meeting early requirements.

(b) Arakan. This area is now served by several radiotelegraph stations through Akyab to Rangoon. It is planned to add radiotelephone facilities so that trunk telephone operation between Akyab and Rangoon is possible. As soon as security conditions permit, much of the previous landline system should be restored. This can be supplemented in difficult sections with the most suitable type of radio.

(c) Chin Hills, Upper Chindwin and Naga Hills. Where deemed essential, landline facilities will be replaced when security conditions permit. Improved radiotelegraph and radiotelephone operation will provide a modicum of telecommunications service. Expansion of the trunk and tributary system must await highway and/or railway construction which can be hastened by the demands of industry and agriculture.

(d) Kachin State. Trunk working between Myitkyina and Mandalay must be restored as rapidly as possible by landlines along the railway. The post alignment is in fair condition and should be restrung with copperweld wire, a portion of which is now in stock. Local telephone and telegraph working can be accommodated on the same conductors. Until this can be carried out, high-frequency radio must continue to provide limited communications facilities. Because of difficult terrain, Putao is best served by radio through Myitkyina.

(e) Northern Shan States. The trunk circuit, Mandalay to Lashio, can be maintained in good order. Carrier working should be added as required. The circuit should be extended beyond Lashio as soon as security conditions permit. Tributary circuits will follow with similar action.

(f) Southern Shan States. Economic development and a return to settled conditions are essential for an extension of the communications lines beyond Taunggyi. Spot communications circuits can be established by h.f. radio as required.

(g) Tenasserim. When conditions permit, the landlines should be extended from Moulmein southwards to Tavoy and Mergui. Adequate tributaries can be added as required. Until then h.f. circuits must be tolerated. Victoria Point, because of difficult terrain, must continue to be served by h.f. radio.

(h) Implementation

(1) *Estimate of expenditure*

Without going over the ground, yard by yard, it is impossible to determine the exact cost of rehabilitating these secondary trunk lines. A fair estimate can be made, however, because the implied project is large, and funds can be transferred as required from one division to another. It is estimated that K20 lakhs should be appropriated for this work.

(2) *Planning and Engineering*

Immediate attention should be given to making the essential detailed plans. Subdivisional officers must gather data on such points as exact conditions of the present alignment, estimates of materials required, and possible changes in location of the alignment for improving security and facilitating maintenance. When the actual work begins, modern techniques and construction equipment should be utilized.

(7) Landline Maintenance

(a) Vegetation removal. In the tropics landlines fare well with the elements but suffer from rapidly growing jungle. During the last few years, great strides have been made in the chemical (herbicide) control of weeds and brush. There is every reason to believe that these methods are applicable in Burma, and could result in considerable savings of both manpower and money.

(1) *Methodology*

There are several methods of applying herbicides:

(*a*) Foliage spraying using water as a carrier.

(*b*) Basal bark spraying (dormant season or year-round) using oil as a vehicle.

(*c*) Basal bark spraying with oil and water emulsion as a vehicle.

(*d*) Cut-stump spraying with oil as a vehicle.

Once vegetation is brought under control, only spot treatment is necessary to maintain a clear line right-of-way. Further details may be secured from the following firms: Thompson Chemical Corp., St. Louis 3, Mo., USA; Dow Chemical Corp., Midland, Mich., USA; Amer. Chem. Paint Co., Ambler, Pa., USA.

(b) Equipment

(1) *General*

The specialized tools, modern materials and equipment used elsewhere for line construction and maintenance are conspicuously absent in Burma. With the efficiency, productivity and work quality of the line staff depending to a large extent on adequate equipment the best available on the world's markets should be procured.

(2) *Transportation*

Without means for moving quickly from one trouble spot to another, full maintenance productivity cannot be realized, nor can optimum service be rendered to the Department's customers. Utility-body trucks can be purchased from many suppliers.

(3) *Standards and training*

Much more emphasis must be placed on adherence to accepted standards. Supervising engineers must be in a position, physically and technically, to show maintenance personnel all techniques for doing the job at hand (see Training, Section 5).

(8) Recommendations

Based on the foregoing discussion it is recommended that:

(*a*) A determined program for the restoration of the Rangoon–Mandalay carrier circuits be adopted under responsible direction. Engineering-planning could be carried out immediately so that imported equipment items might be ordered, and the Rangoon terminal constructed. Line rehabilitation should begin at the end of the present monsoon season.

(*b*) Microwave radio be utilized for the Delta trunk system and the equipment of the entirely inadequate v.h.f. system be used for tributary circuits where single channels over longer hops are desirable.

(*c*) Landline rehabilitation be pushed wherever possible using copperweld wire as an economy measure, and to discourage pilfering of line materials. Also, that Government take a sterner attitude towards all such acts of sabotage so that line structures will be highly respected.

(*d*) The h.f. radiotelegraph program be modified to prevent wasteful spending on a system both unsatisfactory and expensive. HF should be used only in those places where telephone or telegraph landlines cannot be economically maintained.

(*e*) Where a radiotelegraph station is retained for security reasons, its maintenance and operation should be met from the defense budget.

(*f*) Where radio and landline telegraph facilities are available in a community, the same staff should handle both media. As presently arranged many radio operators do not handle a single message from one month's end to the next.

(*g*) Telecommunications make an all-out effort to restring commercial lines on the pole structures that have carried Railways' control lines for some time.

e. The Rangoon Telephone System

(1) General

The telephone service in Burma's capital city leaves much to be desired. Most complaints fall into one or more of the following categories:

(*a*) The system is too small.

(*b*) The service is unsatisfactory.

(*c*) The annual rental is much too high.

Any thought given to rectifying one of the above must involve the other two. For instance, there is little virtue in enlarging the system without at the same time restoring it to an acceptable and less expensive operating standard.

The trend toward fully automatic exchange operation has already extended to 70% of the world's telephones. It is inevitable that Rangoon's future system will be "dial operated." Regardless of the desirability of the automatic system, however, the cost must be considered in the light of local purchasing power. Since recommendations will be influenced by exchange size and system of switching, as well as by equipment and operating costs, each will be examined in some detail.

(2) Subscriber Demand

The determination of subscriber demand depends upon the integration of numerous social and economic factors such as population density, standards of living, number and extent of business establishments

City	*Country*	*Population (est.)*	*Telephones*	
			Total	*Per Hundred*
Tokyo	Japan	6,300,000	297,000	4·7
Colombo	Ceylon	400,000	14,000	3·5
Manila	Phil. Rep.	1,093,000	15,500	1·42
Delhi-New Delhi	India	1,191,000	15,000	1·26
Karachi	Pakistan	1,300,000	14,000	1·08
Djakarta	Indonesia	1,200,000	12,700	1·06
Rangoon	Burma	711,000	3,000	0·42

and the habits and desires of the people. Statistics based on these factors are usually collected by the local telephone administration to guide expansion programs. To supplement the meager data from Rangoon, figures from a few capital cities have been collected to illustrate the likely trends.

Practically every major city in this general area has a telephone expansion program planned, or already under construction. Colombo plans to have facilities for 40,000 telephones by the end of 1959, while Delhi-New Delhi plans to have 30,000 by 1956–57.

(3) The Initial Installation

When new systems are installed, a certain excess is incorporated in the underground system and in the exchange itself to provide for the first five to ten years' demand growth without additional plant expenditure. It is believed that Rangoon should anticipate slightly more than one telephone per one hundred of population. This can be achieved by initially equipping the exchanges as follows:

Main	6,000 lines
North	2,000 lines
Insein	300 lines

for a total of 8,300 lines. For the physical relationship of these offices, see Plate 5.

(4) Estimated Costs

The following "Capital Costs" table is predicated on the assumption that Government will erect a building for the main exchange more suitably located and designed than the 40th Street property. Centrally located housing must also be provided for the North and Insein exchanges. Sites for these buildings are understood to be in the process of procurement. Air conditioning is essential for maintaining a dust-free atmosphere of constant temperature and humidity to permit optimum functioning of the switching devices.

(a) Capital investment

Item	*Life (years)*	*Foreign Exchange (kyats)*	*Local (kyats)*
1. Buildings, including Sites	30	1,00,000	8,00,000
2. Air Conditioning	30	80,000	20,000
3. Exchange Equipment	30	28,00,000	2,00,000
4. Outside Plant	30	52,00,000	28,00,000
5. Telephones and PBX Boards	30	9,25,000	75,000
		91,05,000	38,95,000
Engineering and Contingency		9,10,500	3,89,500
		1,00,15,500	42,84,500
Grand Total		K1,43,00,500	

Note: Imports are CIF Rangoon, exclusive of duty.

(b) Annual costs. The annual costs are comprised of (i) annual investment charges of interest and amortization, (ii) maintenance and operating costs and (iii) administration costs.

(i) *Annual Investment Charges*

Item	*Amount (kyats)*	*Rate (%)*		*Charge (kyats)*
1–5	42,84,500	5·783	2,47,772.65	
1–5	1,00,15,500	6·505	6,51,508.28	
				8,99,280.93

(ii) *Maintenance and Operating Costs*

Item	*Amount (kyats)*	*Rate (%)*		*Charge (kyats)*
1	9,00,000	5·0	45,000	
2	1,00,000	16·5	16,500	
3	30,00,000	4·0	1,20,000	
4	80,00,000	1·5	1,20,000	
5	10,00,000	3·5	35,000	
				3,36,500.00

(iii) *Administration Costs*

Item	*Amount (kyats)*	*Rate (%)*		*Charge (kyats)*
1–5	1,43,00,000	10·0	14,30,000	
				14,30,000.00

Total Annual Cost K26,65,780.93

(5) Subscribers' Annual Charge

(a) Trend of charges. To compute the cost of automatic telephone service to the individual subscriber, it is only necessary to divide the annual cost by the total number of subscribers. From the estimated cost, the following figures illustrate the trend and magnitude of subscriber charges to support a modern automatic telephone system in Rangoon.

Telephones in Use	*Annual Cost*	*Monthly Cost*
4,000	K692	K58
5,000	K554	K47
6,000	K462	K39
7,000	K396	K33
8,000	K346	K29

(b) Basis for calculating charges. Most telephone organizations render a monthly or bi-monthly bill to each subscriber. Either of two methods may be used to compute the amount. The first method operates on the flat-rate principle. A telephone is classified as either residential or business and the subscriber pays the appropriate fee regardless of the number of calls made. The second method makes a similar distinction in telephone usage, but charges a certain minimum fee plus a small amount for each call. Subscribers' meters, to count the outgoing calls on each line, are

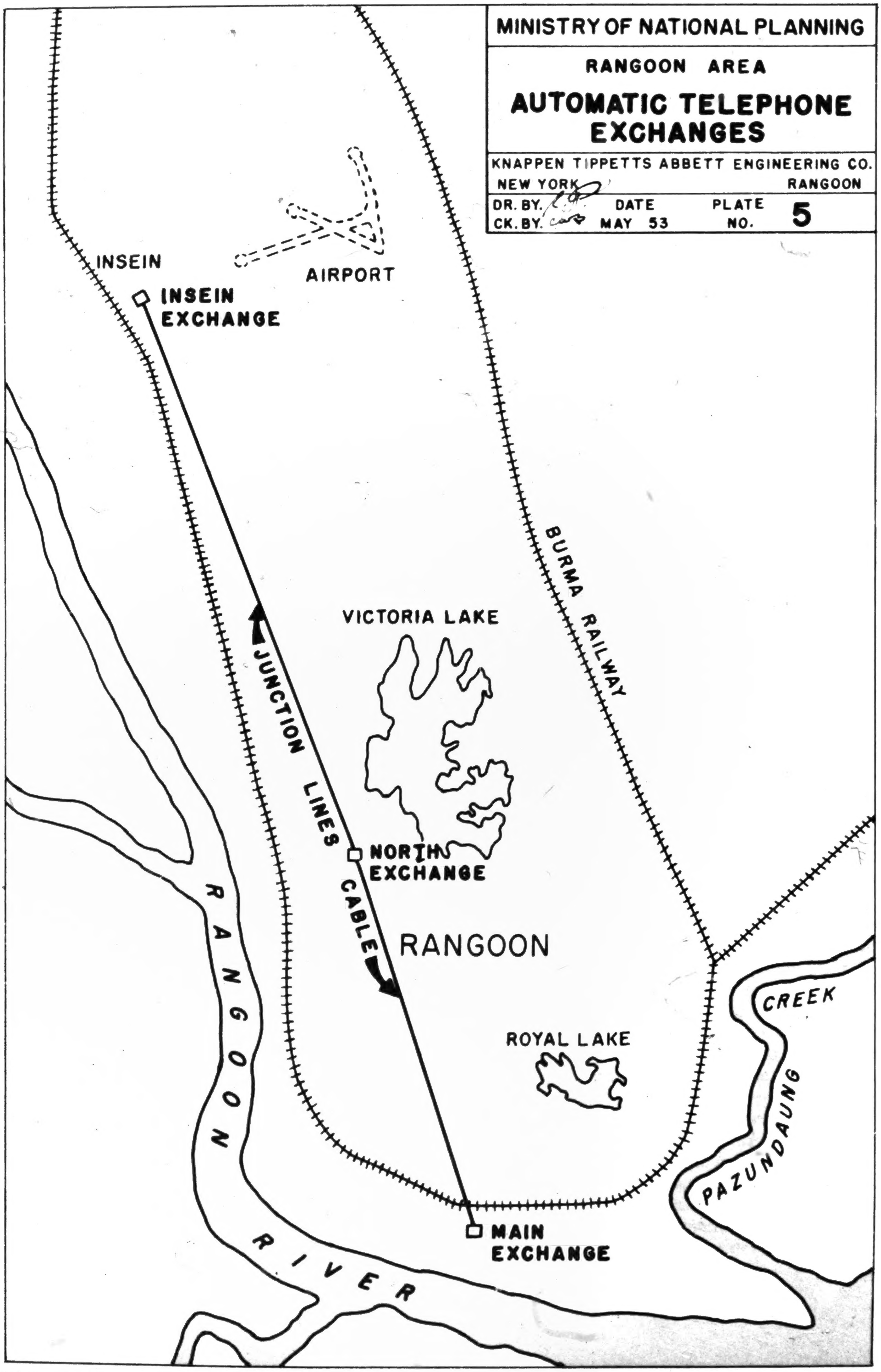
MINISTRY OF NATIONAL PLANNING

RANGOON AREA

AUTOMATIC TELEPHONE EXCHANGES

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY.
CK. BY.
DATE MAY 53
PLATE NO. 5


INSEIN
AIRPORT
INSEIN EXCHANGE
BURMA RAILWAY
VICTORIA LAKE
JUNCTION LINES CABLE
NORTH EXCHANGE
RANGOON
RANGOON RIVER
ROYAL LAKE
CREEK
PAZUNDAUNG
MAIN EXCHANGE

included in the automatic exchange equipment. The second method is more equitable but involves more clerical work. It is more suitable to automatic exchange working.

(c) Protection against non-payment. From each subscriber, it is necessary to collect a deposit in addition to the modest installation fee. This deposit is large enough to cover a month's operation, and protect the telephone administration from the tardy remitter. The procedure, if prompt adjustment of the account is not forthcoming after adequate warning, is to suspend the service. There are no collection difficulties, such as those suffered by Telecommunications, where the telephone administration exercises this rule impartially.

(6) Operation and Maintenance

(a) Preventive maintenance. Most of the duties in an automatic exchange will be much more exacting and specialized than those found in a manual exchange. Technicians will need many skills. The emphasis, in this type of operation, is largely on preventive maintenance—taking the appropriate steps to remove the causes of service interruptions before they can occur. This is a concept which must be learned and practiced diligently, or the automatic telephone system is doomed from the beginning.

(b) Staff estimates. The tables on the next page show a fair approximation of the number and kinds of specialists required in an operation of this magnitude.

The number of people required (and the ultimate success of the scheme) depends largely on the aptitude and willingness of the employees to learn and practice the precise maintenance and operating procedures. It is to be noted that draftsmen, stock clerks and various office staff are provided for under "Administration."

(c) Transportation requirements. It must be remembered that motorized maintenance is a cornerstone of satisfactory telephone system maintenance. Telecommunications' facilities, in this respect, have been most inadequate. Under the automatic system, Insein exchange will begin operations as an unattended unit. In case of breakdown, and for periodic inspection, the services of a mechanic from "North" or "Main" must be available by motor transport. The cost estimates in the table include an allowance for all transport requirements and the minimum number of vehicles is indicated.

(7) Selection of a Switching System

(a) The BPO Survey Report recommendations. This survey, for which the Government contracted with the British Post Office, was to serve as a basis for recommendations and specifications for automatizing the Rangoon telephone system. In general, the recommendations of the report are conventional and reasonable. Exceptions relating to exchange growth estimates, and to the type of switching system offered, are held.

(1) *Future Needs.* The BPO's suggestion that the 30-year Rangoon telephone-line saturation figure might be 6.888 is unrealistic. A review of the statistics in Section E–2–e–(2) indicates that this number of lines in operation today would only put Rangoon on a par with other capital cities in this area. Thirty years of economic development should see Rangoon's telephone needs well into the five-figure category.

(2) *Switching System.* The recommendation of Strowger step-by-step is consistent with BPO policy since it standardized on this method some thirty years ago. No alternative was offered.

(b) Crossbar trend. The Strowger step-by-step is the most widely adopted system of automatic telephone switching. Invented in 1889, and achieving early success, it has demonstrated the practicability of automatic telephone exchanges. Strowger-type equipment is manufactured in many parts of the world; two countries in this area are currently equipping factories for its production. Conservative estimates indicate that there are more telephones in automatic operation through Strowger exchanges than the others combined. For many years, however, the inherent weaknesses of this sytem have been recognized, and engineers have developed diligently toward improved switching methodology. This search has not abated, although circuits using the ingenious Crossbar switch are receiving increasing application. In the United States and Sweden, high ranking in telephone technology and leading the world in per capita telephone service, Crossbar systems have rapidly gained favour, being installed on an increasing scale. Other nations, including Finland, the Netherlands, Denmark, Yugoslavia and Italy are turning to Crossbar switching in expansion and modernization schemes. First patented in the USA in the early 1900s, the Crossbar switch after considerable development was applied to exchange switching in Sweden in 1926. The first exchange in the USA to be so equipped followed some years later. Exchange equipment embodying Crossbar switches is now manufactured in the USA, Sweden and France. At the present time, a constantly expanding total of several million exchange lines of Crossbar switching are in use.

Even though the world's total of Strowger-exchange lines greatly exceeds that of the more modern Crossbar, the recent trend in the face of the earlier adoption of other systems must be recognized. It is believed, therefore, that Burma's best interests would be served by a consideration of these latest developments.

PERSONNEL REQUIRED FOR OUTSIDE OPERATIONS

MAINTENANCE	PERSONNEL						TRANSPORT			
	ENGINEER	SUPERVISOR	LINEMAN AND MECHANIC	CABLE SPLICER	TRUCK DRIVER	COOLIE	LINE-CONSTRUCTION TRUCK	MEDIUM-DUTY TRUCK	"ROVER" OR "JEEP"	MOTOR CYCLE AND SIDECAR
Outside Plant	1	2	6	2	2	15	2	3	1	1
Subscribers' Instruments	—	2	2	—	—	—	—	—	2	1

PERSONNEL REQUIRED IN EXCHANGES

EXCHANGE	AUTOMATIC EXCHANGE				AUTO-MANUAL BOARD			MAIN DIST. FRAMES	
	AUTOMATIC EXCHANGE ENGINEER	SWITCHING EQUIPMENT SUPERVISOR	SWITCHING EQUIPMENT MAINTENANCE-MECHANIC	ENGINE AND BATTERY MAINTENANCE-MECHANIC	SUPERVISOR	OPERATOR	MAINTENANCE-MECHANIC	SUPERVISOR-TESTMAN	MAINTENANCE-MECHANIC
MAIN	1	3	3	3	4	8	2	3	3
NORTH	1	—	1	3	—	—	—	2	2
INSEIN	UNATTENDED			3	—	—	—	—	1
TOTAL	2	3	4	9	4	8	2	5	6

(8) Comparison of BPO Strowger and Ericsson's Crossbar

A report was prepared (November 22, 1952) to provide the Department of Telecommunications with a comparison of important features of the BPO-recommended Strowger system and the modern Crossbar system offered by L. M. Ericsson for automatizing the Rangoon system. Since both organizations have made detailed surveys, it is possible to examine their conclusions and claims in formulating a recommendation. It is understood that these are the only systems under active consideration by Government.

(a) Obsolescence risk. BPO's Strowger as recommended for Rangoon was developed over the years to 1936, when the 2,000-type selector was adopted; since then the design of the selector has been virtually stabilized. The Crossbar offered by Ericsson was developed between 1935 and 1950, to incorporate facilities long demanded by the telephone industry. Since an automatic telephone exchange is considered to have a useful life of about thirty years, that period may be required to write off the cost. Therefore, the more logical choice from the minimum obsolescence-risk standpoint bearing in mind the previously mentioned trend, would be the more modern system.

(b) First cost. Estimates on both exchange systems meeting the BPO's five-year figure of 4,184 lines (this figure is believed to be unrealistically low) indicates that there is little difference in first cost. As the exchange-side exceeds 4,800 lines, BPO's proposed introduction of the fifth digit, thus requiring additional selectors, will cause the Strowger system to become less competitive. It is believed that Ericsson's Crossbar provides several economies that are not apparent from comparing price tags, as will be pointed out in subsequent paragraphs.

(c) Space requirement. From the space requirement figures submitted, it appears that Crossbar requires a maximum floor space of one-half square foot per line, while Strowger requires one square foot per line. The rack height of the Crossbar equipment is 9 ft. 6 in., while 10 ft. 6 in. is required by the Strowger (unless modified from the standard BPO dimension). In both cases, a free space above the rack of at least one foot is required for cable supports. These differences in rack height and floor space requirements are significant from the standpoints of building construction and air-conditioning costs.

(d) Floor loading. Under similar conditions of installation, the Crossbar imposes a floor load of 125 pounds per square foot, as opposed to 180 pounds per square foot specified for the BPO Strowger.

(e) Power consumption. The electric power required by a medium-size automatic exchange is not large, but it is an item of operating expense. The Ericsson Crossbar system offered for Rangoon uses roughly 15 watt-hours per subscriber per day, while the BPO Strowger (basing the calculation on the fact that batteries are usually provided with sufficient capacity to meet the 24-hour load at the 10-year period) consumes considerably more, assuming the same traffic condition in each case. Since a considerable portion of the power is converted into heat, it can have a significant bearing on the air-conditioning plant. The BPO Strowger requires an additional battery for subscriber metering, thus adding to the first cost and maintenance problems.

(f) Outside Plant. It is axiomatic with telephone engineers that every economy made in the outside plant is twice as important as an economy made in the central office, or in the subscriber's station equipment. Consequently an exchange system which permits outside plant economies is most desirable. It must be pointed out, therefore, that the Ericsson Crossbar permits a line-loop resistance of up to 1,200–1,500 ohms (exclusive of the instrument), whereas the BPO Strowger has specified not more than 650 ohms for dependable signaling. This difference may not seem important until considered in terms of the gauge (and cost) of the conductors in the cable plant. In the final analysis, this tolerance of LME's Crossbar could result in a copper saving of up to fifty per cent. A potential economy of this magnitude should not be disregarded by a telephone administration faced with purchasing much new cable.

(g) Junction lines between exchanges. The BPO Report's reference to "private wires" in estimating the junction-line requirements is confusing. Since their final design data have not yet reached Rangoon, the point remains unclear. The fact remains, however, that the more favourable grouping offered by Ericsson's Crossbar permits a junction-cable economy of some magnitude. The conductor gauge of the junctions is the same for both systems.

(h) Dial speed. It is generally understood that the impulses produced by the subscriber-instrument's dial guide the automatic exchange equipment in establishing the desired ringing and talking circuits. What is not so well known perhaps, is the important influence of dial speed, make-and-break ratio, and pulse shape upon the performance of an automatic switching system. The Ericsson Crossbar system permits dial-speeds from 8 to 22 impulses per second, whereas the BPO Strowger dials must be maintained within a narrower range of from 7 to 12 (optimum 10) impulses per second. It is well known that faster operating equipment which will eventually incorporate faster dials is receiving attention on many automatic-exchange design fronts.

It is further noted that for an exchange of 3,314 lines, such as the BPO suggests for "Main," 800 selectors on various levels, must operate from subscriber-dial pulses. In an equivalent Ericsson Crossbar system, the dial pulses are received by only 30 registers whose relays are designed solely for receiving and storing these impulses. It is much easier to maintain this small number of impulse-receiving relays than to maintain the 800 selector-relays which govern directly the numerical stepping function of an equal number of Strowger switches.

(i) National dialing. In the interest of future expansion of the automatic telephone system in Burma, it is pointed out that many features desirable in a country-wide dialing scheme are already embodied in Ericsson's Crossbar. To provide these facilities with the BPO Strowger would require expensive modifications.

(j) Maintenance. One of the outstanding advantages of the Crossbar switch are its modest maintenance requirements. L. M. Ericsson claim that exchanges using their equipment report that not more than one-half hour's maintenance per subscriber per year need be anticipated. The BPO Report estimates (basing the calculation on the number of maintenance men specified) approximately two hours maintenance per subscriber per year. Figures obtained from Pakistan and India, however, indicate that maintenance of BPO-type Strowger may require as much as seven hours per subscriber per year.

It is somewhat difficult to assess the value of reduced maintenance, but a saving of labor means lower operating costs, and less out-of-order time means better service to the telephone public. It is of interest to note that the general reliability and low maintenance requirements of Crossbar-exchange components are contributing factors to its selection by many administrations for rural automatic exchanges which must operate totally unattended.

(k) Spare parts consumption. It must be expected that any automatic telephone exchange will require certain replacement parts during a given period of operation. In the best of equipment a relay coil may open or a condenser may develop a short circuit, for such is the nature of delicate electrical apparatus. However, there has been great progress in component design, and with new materials, telephone-design engineers are striving continually towards fault-free equipment. Many feel that the closest approach, to date, has been made with circuitry based on relays and Crossbar switches. In comparing the two systems offered for Rangoon, it is logical to assume, since relay contact wear is proportional to selector-circuit current, that the BPO Strowger will require more frequent renewals. This matter is relegated to a lesser place in the spare-parts consumption picture, however, by the replacement rate of selector wipers and cords. Figures from neighboring countries indicate that the annual rate can be as high as three wipers per subscriber line. This represents an operating cost of considerable proportions which is not applicable to a Crossbar system. There are other parts which require frequent replacement in the Strowger selector. This handicap, together with the fact that selector mechanisms require precise adjustment and lubrication tends to offset the advantages of the simpler circuitry of the BPO system.

(l) Character of operation. As previously mentioned, exchanges have been designed around the Crossbar switch to eliminate certain faults of earlier systems. The adoption of noble-metal contacts has improved the quality of the talking circuit over that permitted by the base-metal bank contacts of the Strowger selector. Besides this contact improvement, the Crossbar switch has increased connection speed, and at the same time eliminates the mechanical chatter and vibration inherent to the selector. As a result, the Crossbar central office is quieter. All of this, while perhaps difficult to evaluate in exact terms, contributes to the greater overall satisfaction with the automatic telephone system.

(m) Automatic-area numbering. In the survey report of the BPO, it is indicated that a maximum of 7,000 exchange lines can be connected to the automatic area before adding the fifth digit. However, according to the numbering scheme outlined, a mixed 4 and 5-digit system will be utilized at the 4,800-line figure. By contrast, the LME Crossbar will permit the operation of 9,000 automatic lines. Therefore as offered for Rangoon, the Crossbar system can accommodate almost 50 per cent more subscribers than the BPO-planned Strowger before resorting to the expense of another group-selector stage. This is a most important point for telephone administrators to keep in mind when planning a new system where considerable expansion must be anticipated. One of the factors contributing to LME Crossbar's much more favorable number utilization is the full employment of the "1" level. BPO, as do certain other administrations, discards the "1" level for full subscriber use because of the risk of malfunction due to spurious initial single impulses. LME apparently does not consider the risk important enough to warrant this curtailment, and as a consequence provides a substantial saving.

(9) Recommendations

The facts and figures presented in this report are the result of a general study of the Rangoon telephone system. During the course of this survey, over a period of many months, suggestions have been made to and discussed with Telecommunications and Ministry officials. Consequently, some of the following items may already be under active consideration. Based on conclusions reached in this survey, it is recommended that:

(*a*) Prompt consideration be taken of the most pressing need for an administration within Telecommunications which is technically and organizationally designed to manage the affairs of the Rangoon telephone system. This must take precedence over any serious move towards automatization. It is further urged that the newly appointed divisional engineer be given the latitude and assistance he will need, over an adequate period of time, to straighten out and modernize the operations of this expanding system.

(*b*) The program for automatization be pushed so that the new manual exchange need not expand beyond 2,000 lines. It is reasonable to expect South exchange (1,000 lines), bolstered with a few replacement parts, to serve for another two or three years without excessive breakdown. With 3,000 lines in operation, the cost of installing the third 1,000-line board as well as the cost of the additional power supply could be saved. This new 1,000-line board could be sent to Mandalay where it will be needed to meet the anticipated demand when trunk working is re-established and the program for industrialization begins to take shape (see Section E–2–f–(8)).

(*c*) Telecommunications procure a site within the specified area (Mogul, Fraser, Dalhousie, Sule Pagoda), and erect thereon a functional automatic exchange building. This will bring about housing and plant economies by locating the exchange in the future center of maximum telephone density.

(*d*) The modern LME Crossbar exchange system be adopted in preference to the BPO Strowger for reasons outlined within this report. Because of Rangoon's importance, present and potential, as the capital city of Burma, it is further urged that provisions be made for 6,000 lines in "Main," 2,000 in "North" and 300 in "Insein" (including the Mingaladon area). Incorporated should be public telephone facilities in public buildings, cinema vestibules, and 24-hour establishments such as police and fire brigade headquarters, BRR station and the air terminal.

(*e*) Telecommunications establish well-planned training classes for all grades of telephone technicians as one of the first steps in improving and standardizing operations as outlined in Section E–5. Also, that selected technicians be sent to the United States or Sweden for training in modern telephony practices.

(*f*) Stern measures be applied to the collection of unpaid telephone bills, and the departmental regulations, in this respect, be more vigorously enforced without preferment for subscribers who are members of the Government unless authorized by law or regulations.

(*g*) Telecommunications standardize, by specification and drawings, the apparatus and materials needed in the operation of the telephone system. Enough laboratory facilities must be provided to permit essential electrical measurements. Sufficient equipment performance data should be recorded to serve as a basis for future purchasing.

(*h*) Improved practices in outside plant construction and maintenance, notably distribution point and drop wiring, be adopted. Adequate motor transport is also long overdue.

(*i*) Large-scale city maps showing outside plant installations be maintained accurately, and kept current.

(*j*) Complete and accurate cable-test data be secured to permit trouble location with instruments. In the absence of this information it is impossible to decide which cables can be used for automatic ringing (new C-B boards) or full automatic exchange operation. Wet-weather cable faults are difficult to find without this information.

(*k*) Adequate accounting facilities be established so that an accurate compilation of operating and capital costs can be quickly obtained.

f. Telephone Exchanges Outside Rangoon

(1) General

Today, the telephone is recognized as an economical and social necessity, yet not one of the 53 communities in Burma of over 10,000 population enjoys optimum telephone service. This is the basis for the contention that once the trunk-line system is re-established, expansion and rehabilitation of the various telephone exchanges will be Telecommunications' biggest responsibility for some time to come. Only early and aggressive attention to engineering, planning and procurement will enable the Department to meet the demand with competence, speed and thoroughness. The really difficult problem in this respect is keeping a balance between service, operating expense and revenue. Telecommunications must not for a moment deviate from the goal of a faster, more dependable and more economical telephone service for an ever-increasing number of people.

(2) Subscriber Demand

As previously stated, the number of telephones required to satisfy the needs of a community depends on many factors and variables. The number of government offices, the degree of industrialization, the commercial and social relationships between sections of the country, and the desires and the habits of the people themselves influence the final telephone saturation figure.

(a) No master telephone plan. Planning for Burma's near future network suggests a master plan for a trunk-lines system with clear-cut goals for the next two, five and ten years. Unfortunately, the Department has put very little definite shape to the blocks of accomplishment for these periods, and consequently can promise little more than the limited local service most large communities now have. Trunk-line planning will be effective only when the top policy-makers understand fully the limitations imposed by pursuing the radiotelegraph program rather than rehabilitating and expanding the landlines.

(b) Surveys necessary. Before an expansion plan for any community takes shape, a formal survey must be conducted by the telephone administration to determine its extent and direction. This prevents wasting money on an oversized plant, or losing money and good will by an inadequate system. It helps to determine the best location for exchange buildings, and allows designers to mesh their plans with those of the municipality, to the advantage of all concerned. As each installation must be independently designed, Telecommunications must furnish its district officers with complete information and instructions for initiating these surveys.

(1) *Survey details*

There is no short cut for avoiding the requirement for detailed questioning to determine who are potential subscribers. Such information must be solicited on the premise that adequate trunk facilities are to be provided, rates are to be lowered, better subscriber instruments are to be installed, and improved local service is to be guaranteed. The survey is an exacting task, and not to be treated lightly by the responsible personnel.

(3) Estimates of Telephone Exchange Expansion

(a) General data only. The collection of the accurate data required for the design of telephone exchanges in each of the provincial towns is beyond the scope of the survey made for this Report, but such information can and must be obtained by Telecommunications' personnel (under expert direction, if necessary) as outlined previously. The present survey has, however, disclosed certain pertinent facts:

(1) The quality of service now rendered is generally at an unsatisfactory level.

(2) The equipment, both inside and outside plant, is obsolete and inadequate.

(3) The exchanges are for the most part unsuitable for connection into a high-grade trunk system.

(4) Maintenance standards have not been observed, whether because of material inadequacies or for other reasons.

It is estimated that most of the outside plant will require a complete overhauling and replacement.

(b) Initial exchange lines required

(1) *Urgency*

Since Telecommunications has not completed the first-stage planning for the rehabilitation-expansion program, very few data were available for the following estimate. However, the urgency for indicating the order of expenditure involved demands action, even at the expense of accuracy.

(2) *Basis for Estimate*

(*a*) *Population above 10,000.* Central battery exchanges are more economical than magneto exchanges for medium-sized systems, but require a dependable source of power. It is believed that this will be provided throughout Burma by the electrification program. Therefore, C-B exchanges are indicated for the 52 communities of more than 10,000 population outside the Rangoon area. It is estimated that approximately 3,500 lines of C-B exchange equipment will be available upon the mechanization of Rangoon's exchanges, leaving about 5,000 lines to be purchased.

(*b*) *Population between 4,000 and 10,000.* Magneto-exchange equipment, now in use throughout Burma, can be allocated to the 67 communities having populations between 4,000 and 10,000 as required. The cost estimate for this phase of the program must be calculated at a later date when better information assures acceptable accuracy, and when the growth of the trunk-line system can be evaluated.

(4) Capital Investment

All cost fixtures are given on a "per line" basis to facilitate making estimates for systems of various sizes up to 600 lines.

Item	*Life (years)*	*Foreign Ex-change (kyats)*	*Local (kyats)*
1. Exchange Equipment	30	155	15
2. Outside Plant	30	345	175
3. Subscribers' Instruments	30	70	5
		570	195
Engineering and Contingency (10%)		57	19.50
		627	214.50
Estimated Total Capital Cost (per line)		K841.50	

(5) Annual Costs

This is comprised of the annual investment charges of (i) amortization and interest, (ii) maintenance and operating costs and (iii) administration costs. All figures are liberal and provide for first-class equipment, operation and maintenance.

(i) *Annual Investment Charges*

Item	*Amount (kyats)*	*Rate (%)*	*Charge (kyats)*	
1–3	627.00	6·505	40.79	
1–3	214.50	5·783	12.40	
				53.19

(ii) *Maintenance and Operating Costs*

Item	*Amount (kyats)*	*Rate (%)*	*Charge (kyats)*	
1–3	841.50	25·0	210.38	
				210.38

(iii) *Administration Costs*

Item	*Amount (kyats)*	*Rate (%)*	*Charge (kyats)*	
1–3	841.50	10·0	84.15	
				84.15

Total Estimated Annual Cost per Line	347.72
Total Estimated Annual Cost for an 8,500-line Program	29,55,620.00

(6) Housing

(a) Exchange. It is to be noted that no provision for new housing has been made in the above estimate because the extent of this requirement has not been ascertained. It has been observed that some exchange building must be appraised from the standpoint of utility and location when the program is planned. It is pointed out that where new housing is required, the economic and technical advantages of having the telephone, telegraph and post-office facilities share a building should not be overlooked. Modern functional design merits high priority.

(b) Staff. Consideration of living quarters provided by the Department seems to rank in the minds of employees as the most important aspect of the job. The whole policy of furnishing living quarters must be settled by the Ministry to prevent staff dissension at a time when maximum cooperation is essential.

(7) Mandalay Telephone System

(a) General. The installation of a new 400-line magneto exchange was recently completed in Burma's second city. This expansion was accompanied by extensive outside plant improvements, mostly in the form of new cable. Considering the fact that Mandalay has a population of more than 182,000, the present telephone system will not be able to meet the demand for connections when the Rangoon–Mandalay carrier trunks go into operation permitting through operation to other districts. Now is the time to think about further expansion.

(b) Subscriber demand. The North Burma Division has not undertaken the accurate determination of future telephone subscriber demand. However, an estimate adequate for these purposes can be made from presently known facts about telephone usage in Burma. On this basis, it is estimated that one 1,000-line C-B exchange will see Mandalay through the five-year period following restoration of trunk service to Rangoon. Under favorable conditions of industrialization and improved standards of living, the number of telephones may double in a 20-year period.

(c) Automatic or manual. Before the details of expansion are discussed, the most desirable type of exchange operation should be determined. There is much to be said for either automatic or manual operation for an exchange of this size. Where labor costs are high, or where there is any great threat of labor stoppages, automatic operation is especially attractive. In any case, its greater reliability and personnel economies have justified its use for almost 70% of the world's telephones. On the other hand, the lower initial cost of manual equipment with more modest maintenance requirements offers serious financial inducements. The initial cost of automatic will average about K400 per line more than manual equipment. Fixed charges, considering return and depreciation, will aggregate at least 8%. Therefore, the excess annual fixed charge of automatic over manual will be K32 per line. At least ten operators will be required for toll, inquiry and service, at an added annual cost of K15 per line. The annual maintenance cost may easily amount to K8 per line more than the manual exchange. Altogether, this amounts to K60 per line, per year, to be compared to the manual board's operating figure of K45. For a slightly larger exchange, the automatic system would be more economical.

(d) Exchange building. The present central building is too small to accommodate much exchange growth. Consequently, a new building is required for this anticipated expansion. All of the elements of good telephone engineering must be exercised to insure that the type of building and its location are optimum.

(8) Recommendations

(a) General. It is recommended that plans be laid immediately for expanding local telephone service throughout Burma as outlined in the foregoing paragraphs. This should include the drawing up of complete instructions and forms so that local subdivisional officers can conduct a subscriber-demand survey, and furnish the necessary technical information for laying out the outside plant.

(b) Mandalay. Based on the assumption that Rangoon's automatization plan will be implemented in the very near future, it is recommended that 1,000 lines of the new C-B exchange equipment released from Rangoon be installed in Mandalay. Efforts to obtain the essential information for designing the outside plant system should be undertaken immediately. The designation of manual switching is believed advantageous because the need for expansion will be met efficiently and economically with equipment at hand. It is not believed expedient to have two automatization programs under way simultaneously, because of the dearth of skilled telephone technicians. When the extent of Mandalay's telephone expansion can be evaluated, definite plans can be formulated for replacing the C-B exchange by the automatic exchange or remaining on a manual basis. If the former, the C-B equipment can always be reinstalled in smaller units at other locations.

g. Telephone System Maintenance

(1) General

Maintenance is one of the major items that must be taken into consideration in designing, manufacturing and operating a communications system. Test equipment and men trained in its use must be provided to handle routine equipment tests and to expedite repairs on defective units. The tropical climate is more severely destructive to communications equipment than are more temperate climates. For Burma, this puts an additional emphasis on the adequacy of the maintenance procedures to be followed.

(2) Maintenance Standards

Within this report there have been several references to Telecommunications' lack of equipment standards. The same applies to maintenance procedures. Regardless of the size of the telephone system there is a distinct difference between outside and inside engineering, operations and maintenance. Each area must have its characteristic equipment and standardized procedure for its use. Standards of workmanship and repair must be established, and until teeth are put into the rules governing adherence thereto, Telecommunications' service quality will remain definitely submarginal.

(3) Materials and Stores

The Superintendent of Stores has the very heart strings of the Department in his hands! If he stocks the material required in adequate quantities, the necessary work can proceed. If he does not, he provides the maintenance staff with the best possible reason for doing nothing. He must receive guidance and help from the operating staff as to materials to be ordered in plenty of time for the ordering-delivery interval. Without standardization, too much high-level activity is involved for each small order such as telephone instruments. The present procedure requiring a meeting of top executives and a group decision to place a small order has resulted in procurement of several types of instruments, none of whose parts are interchangeable. Chaos therefore prevails in lieu of a systematic instrument maintenance program. However, a major portion of the prevailing "make-shift" or expedient type of maintenance so detrimental to service is caused by unrealistic and impractical stores operations, as well as the previously mentioned lack of standards.

(4) Tests and records

(a) Necessity. Adequate records are needed in an effective maintenance program. Many faults cannot be readily traced or properly repaired because the local technician has no accurate or complete record of the operating characteristics to enable him to decide when the circuit is normal. The resulting approach by trial and error leads to sub-commercial circuit conditions.

(b) Setting-up records. Practice in well-organized telephone systems is to make all normal circuit test values a matter of record. On the same form there is space for classifying and entering all departures from normalcy as well as the steps taken (and time required) for returning the circuit to service. In this manner a case history for every subscriber's circuit is developed to the continuing benefit of the maintenance program. Where such orderly methods are employed, there are no instances of telephones being out of order for days or weeks.

(1) *The Trouble Log*

A daily log sheet gives a running account of failures, tests and repairs. From this record, the average out-of-service time per breakdown can be calculated, and the trends towards various types of failure recognized. All of this is an excellent performance check on both men and materials, and should indicate whether the subscribers are getting the service they deserve. In Burma, such organized maintenance is not emphasized. To partially correct this a convenient log sheet should be designed and printed in quantity. This will facilitate the use of the same procedure at all exchanges in the country.

(c) Test records for preventive maintenance. Once test information covering normal operation has been recorded, advantage can be taken of routine operating tests before trouble develops to the extent of putting the circuit out of service. Operations engineers have compounded the theory of preventive maintenance from experience extending over many years. The basic idea is to service and remove impending faults before they can degrade the operation of the system. Preventive maintenance of this kind is practised in many fields. Its application to telecommunications is especially appropriate considering the importance of the service rendered. As information is collected in the areas most likely to fail, attention is directed to them. In this manner, a complete preventive maintenance program is devised.

(1) *Instrumentation*

Satisfactory preventive maintenance requires that test instruments be made available to the staff, and that the staff be well versed in their use. Both speed and accuracy are necessary attributes, without which the value of instruments to the department is questionable.

(5) Tools, Instruments and Transport

The tools and instruments locked up in Telecommunications' godown are earning interest for the Government from departmental revenue, but are not available to the employees for use in assuring the everyday working of the system. Employees who can ill afford such expenditures are furnishing their own tools because of the Department's budget restrictions. Although this whole matter is treated in Section 7, it is mentioned here to illustrate the complete frustration of maintenance effort.

The maintenance equipment and methodology available to Telecommunications is shockingly meager. There is also a tendency to overstaff whereas it is proper equipment rather than increased manpower which is required. The proper instruments and tools, together with reasonable spare parts, and a means of getting to the scene of a fault quickly would permit two well-trained men to accomplish what a dozen, as now operating, cannot do.

The need for motorized transport seems to have received very little attention. This situation should not be allowed to persist. In this connection, several truck chassis (Ford three-ton) are awaiting bodies at the Botataung godown. These are too heavy for general installation and maintenance, but are ideal for medium-duty line construction and service purposes. The locally made general-purpose body is not nearly as useful (nor as good an investment) as the functional types available at reasonable cost from the United States.

(6) New Installations

Good service and good public relations go hand-in-hand in the telephone industry. The prevention of trouble is always a major factor in good service. Many maintenance problems can be eliminated before they begin if the original installation is made correctly.

(a) Enforcing proper procedures. A great deal depends on the installer's ability and integrity in the matter of following approved practices. The engineer in charge of this work can accomplish much by:

(1) Providing the installers with the proper tools and specifications.

(2) Being sure that the men are trained in the use of both.

(3) Inspecting carefully a fair percentage of each man's work.

(4) Making a special study of each case of station trouble occurring within two months after installation.

(5) Going over trouble with the installer when it occurs in a new installation, so that mistakes are not repeated.

(7) Honesty

Cases have been reported of telephone maintenance men demanding and getting "small pay" from subscribers for repair service. No program for bringing these small-time racketeers to account for such flagrant violations of regulations has been instituted. Tolerance of such practices reflects on the management of the organization.

(8) Recommendations

Telephone maintenance should be elevated to a high technical and business plane. It is recommended that:

(*a*) Telephone maintenance standards be established and rigidly enforced.

(*b*) Maintenance activities be so organized that one visit is sufficient to locate and repair the fault. This will eliminate the present evasion of responsibility and inherent delays.

(*c*) Material necessary for proper maintenance be carried at all times by Telecommunications stores. This must be given a first priority by all concerned.

(*d*) Maintenance men be provided with the necessary tools and transport for meeting their responsibilities quickly and competently.

(*e*) A complete system of tests and records be set up and rigidly maintained to assist outside plant maintenance personnel in locating cable faults. The present trial and error procedures are untenable in this age of precise electrical measurements.

(*f*) Daily trouble records be meticulously kept so that average "out time" can be calculated, and that the fault reasons be catalogued.

(*g*) Functional telephone-plant bodies be obtained for the Ford truck chassis at the Telecommunications stores.

(*h*) A determined drive be undertaken to eliminate the dishonest maintenance men who demand bribes for departmental attention to faulty telephone operation.

h. Central Telegraph Office

(1) General

The Rangoon central telegraph office is located in the Telecommunications headquarters building, Phayre and Dalhousie Streets. In this building are the instrument room, the public telegraph booking office, and the accounting clerical staff associated with these facilities. All of the telegraphic services with the exception of the Marine Shipping Station are controlled from this location. Messages for the greater part of the city are also delivered from this point.

(2) Telegraph Circuits

(a) Point-to-point foreign circuits. All of Burma's foreign traffic moves over the Rangoon–Colombo, or the Rangoon–Madras circuits. Average weekly traffic (in both directions) totals about 8,000 messages through Colombo, and 5,000 through Madras. Because of the large amount of press and diplomatic traffic, these messages may involve several hundred thousand words.

(1) *High-speed Automatic Morse*

At the transmitting end, the messages are transferred to punched paper tape by means of a keyboard perforator. The tape then passes through a motor-driven device which keys the radio transmitter at any desired speed up to perhaps 150–200 words per minute. At the receiving end, the signals are inked on a moving paper tape by an undulator. These dot and dash characters are transcribed manually to telegraph blanks by an operator using a typewriter, as the tape is pulled along.

(*a*) *Limitations.* Even though atmospheric and propagation conditions permit the radio circuit to move this traffic at high speeds, delays occur in the punching and transcribing operations. Although several perforator and transcribing positions permit large traffic volumes, when conditions deteriorate, there is an appalling waste of skilled manpower.

(*b*) *Staff.* For operating these two circuits on a three-shift day, 37 positions have been allocated at the CTO, although 30 are presently carrying the load with some difficulty. Of the 30 operators, seven are from the Radio Division, and the rest are Traffic Section employees.

(b) Point-to-point domestic circuits

(1) *Type and Operation*

These utilize either radio or landline facilities, and are all manually operated. At the present time, there are 14 radio and 9 landline positions, each requiring the services of a skilled operator. The actual tuning, maintenance and control of the radio equipment are performed by technicians at the receiving and transmitting centers. Very few of these operating positions are equipped with typewriters.

(2) *Staff*

For the various services of booking, training, clerking, accounting, operating, and message delivery, approximately 250 people are employed.

(3) Equipment and Facilities

(a) Operation. Except for an acute shortage of telegraphers' typewriters and radio headsets, it can be said that the operating equipment is adequate. The lack of typewriters results in lower productivity and greater operator fatigue while producing a much less legible message. From the hygienic point of view, each operator should have his or her own headset. Motor-driven tape pullers should be provided to increase the efficiency of operators transcribing inked characters from received tapes.

(b) Circuit distribution and supervision. The Rangoon CTO has no supervisory control board, and the lines to and from the centers terminate at the operating positions. Consequently, to check any complaint involving signal quality or operating practices, the supervisor must go to the operating position in question. Supervision thereby suffers. Order-circuit facilities to the receiving and transmitting centers are conventional telephones operating through the exchanges. This is a slow cumbersome arrangement for the brief, frequent communications required in an operation of this kind. Modern practice dictates that all receiving and transmitting circuits should pass through a central control board. This permits the supervisor to have a continuous and instantaneous check on signal quality and utilization of each circuit. A key and sounder circuit with each of the centers provides rapid and convenient order channels without telephoning. Since the sounder can be heard from some distance, more prompt service can be rendered by operating personnel.

(4) Message Handling

(a) Booking. Most messages are filed at the booking office although a few are taken at branch offices in the outlying districts of the city, and then forwarded to the CTO on a landline circuit. It is anticipated that a public booking office will be opened at the Secretariat. Inadequate facilities and outmoded practices at the booking office make filing of messages a slow, tedious process. Instead of one clerk consummating the whole transaction, several are involved before the customer can complete his task. Each of these "window stops" involves queueing and delay. Another objectionable feature is the affixing of stamps to the message for the amount of the telegram fee. Until modern cash registers capable of stamping the message and rendering a receipt for the customer can be requisitioned by Telecommunications, steps should be taken to simplify what should be a minor, rapid transaction. For instance, stamps can be sold at every window to eliminate traveling between windows. Not more than two or three minutes should be required to file a message. This whole matter, with recommendations, was brought to the attention of the Director several months ago.

(b) Delivery

(1) *Sorting of Messages*

Received telegrams are sent down from the CTO to the rear of the booking office where they are sorted into pigeon holes from which they are turned over to designated peons when the accumulation warrants. They, in turn, enter the names and addresses in a "peon book," and then set out to make the deliveries. Considerable delay is inevitable.

(2) *Delivery Peons*

A distinction has been made between "mounted" and "foot" peons, even though the salary and qualifications are the same, to the extent that messages are held for allocation to the "type" of peon designated for that particularly locality. Better service could be rendered if a "foot" peon could be ordered out on a bicycle, if required, or vice versa.

(*a*) *Uniforms and equipment.* It is believed that adequate provision has now been made to supply waterproofs to peons for the wet season. It is doubtful if they achieve the three-season life anticipated per garment. The uniform allowance, if it were implemented, would furnish two suits per peon. However, at the present time, the peons get nothing. Enough changes should be provided so that a fresh suit can be kept ready for use, especially in wet weather. The "esprit-de-corps" of workers, their pride in organization stimulated by smartly turned out messengers, is important both to performance and to public confidence.

(3) *Bicycle Shop*

Recently, enough new bicycles have been provided to eliminate some of the delivery delays previously experienced. The bicycle shop is a most necessary adjunct of the service. It has been and still is suffering from inadequate equipment. Power grinding and drilling as well as brazing facilities and sufficient spare parts should be provided to permit the two mechanics to render the best possible maintenance and repair service.

(4) *Motor Cycle Delivery*

Other Telecommunications administrators have found that the use of motorcycle-mounted messengers has resulted in considerable savings and greater satisfaction, especially on long and night trips. A few motor cycles are available, but need extensive repairs.

(c) Abbreviated-address messages. As now operating, the process of adding the delivery information to messages bearing a cable address consume altogether too much time and effort. It requires checking a card file for address particulars and transcribing them on to the delivery envelope by longhand. All of this causes congestion and delay. Plans to improve this situation, with incidental staff economy, by using Addressograph equipment have been delayed for many months.

(5) Manpower

(a) Supervision. In charge of the CTO is a superintendent under the Director who also has a personal assistant, traffic, to direct the major administrative routine, and to act for him in traffic matters. Supervision of the various subordinate activities is shorthanded. During the present period of transition and rehabilitation, the number of authorized supervisory posts has not kept pace with the needs. In some cases telegraphists are acting in a supervisory capacity without extra compensation for the additional responsibility.

(b) Utilization

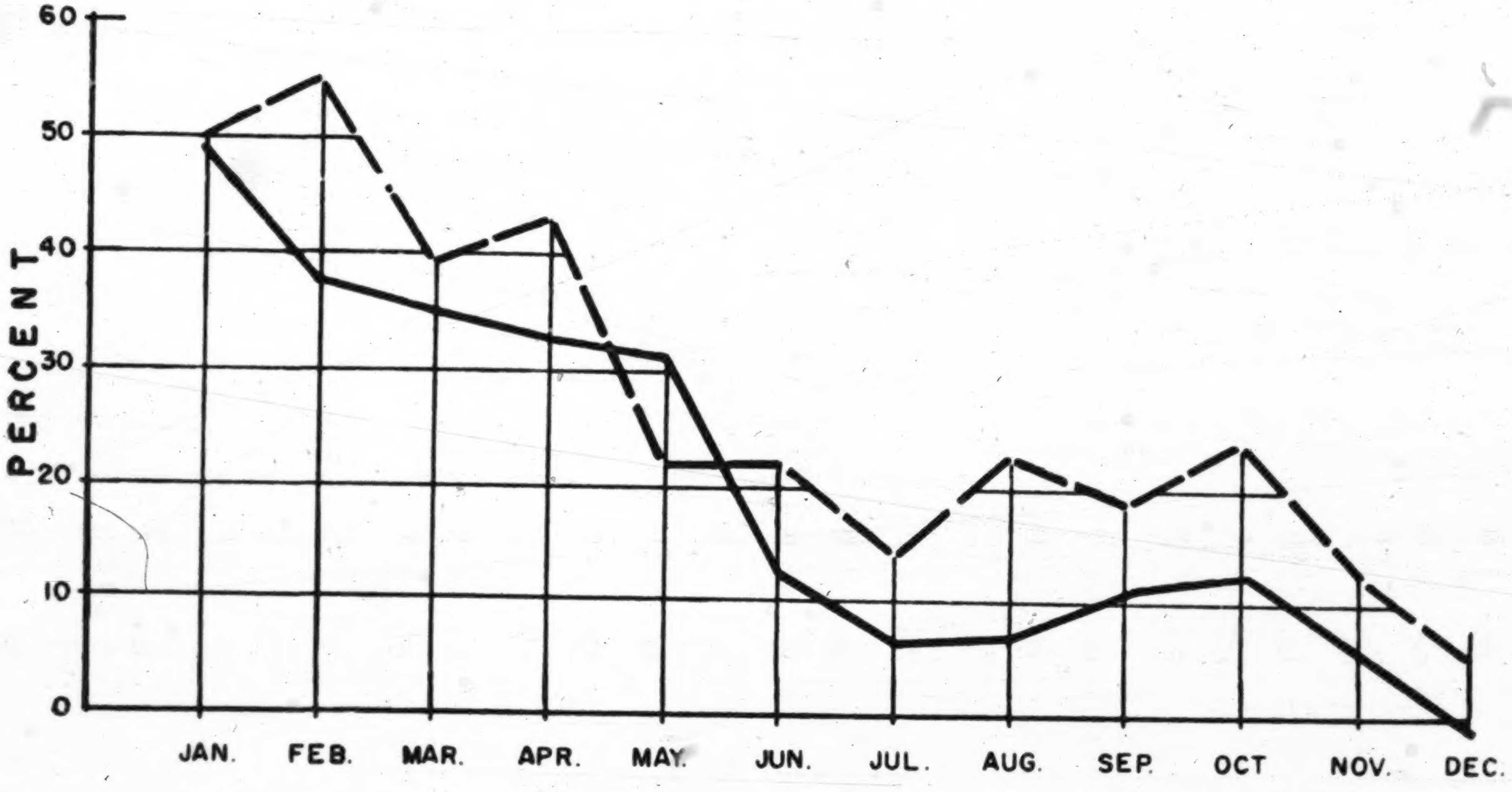
(1) *Mechanization Overdue*

A tendency to increase manpower rather than mechanize operations for greater efficiency is manifest in the CTO. Examples of this were observed in the transcribing of radio messages; shortages of operators' typewriters; hand addressing of delivery envelopes; and the lack of teleprinters and bookkeeping machines. In the highly scientific and systematized procedures required for the conduct of modern telecommunications, too many people get in each other's way and introduce a real impediment and delay into the transmission or delivery operation. Better productivity could be achieved in both the clerical and operating areas if a vigorous program were undertaken to provide the needed office equipment.

(2) *Operating Staff Shortages*

As illustrated by Plate 6, the amount of traffic handled is increasing yearly; yet no additional operators have been added to meet this demand. With landline telegraph offices reopening in the districts and calling on the Rangoon CTO for staff, the situation merits recognition before it deteriorates further. Efficiency must be increased or operators added. Already, overtime allotments are being exceeded in

MONTH	YEARS 1950	1951	1952	PERCENT INCREMENTS '51 OVER '50	'52 OVER '51
Jan.	47,704	71,245	71,631	49·2	0·05
Feb.	47,195	65,400	76,799	38·5	17·4
Mar.	55,484	74,857	77,838	34·9	4·0
Apr.	49,326	65,451	71,911	32·7	9·9
May.	57,564	75,245	68,922	30·7	−8·4
June.	60,382	66,540	73,002	10·2	9·7
July.	64,266	68,087	73,262	6·0	7·6
Aug.	62,505	66,701	77,243	6·7	15·8
Sep.	64,905	71,790	77,270	10·6	7·6
Oct.	65,115	72,915	81,512	12·0	11·8
Nov.	65,789	69,144	73,419	5·1	6·2
Dec.	72,044	71,332	75,421	−1·0	5·7
Total	712,279	838,707	898,230	16·3	7·1



—— % INCREASE OF 1951 OVER 1950

— — % INCREASE OF 1952 OVER 1951

(1950 IS ZERO REFERENCE)

MINISTRY OF NATIONAL PLANNING

COMMUNICATIONS

TELEGRAMS HANDLED BY RANGOON C.T.O.

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. E-J.P DATE
CK. BY. C.W.B. JULY 53
PLATE NO. 6

order to move the traffic at hand. In this connection, it must be understood that moving traffic through the interference and static of the average radio circuit is not as simple as working over a noise-free landline. Consequently, staff productivity suffers by comparison.

(6) Desirable Changes

(a) **Need.** The several items described briefly in the foregoing paragraphs, while individually very modest, collectively have a tremendous influence on the operation of this most essential adjunct of the telegraphic service. Procurement action should be taken without further delay.

(b) Cost estimates

(1) *Capital Investment*

Item	*Life (years)*	*Foreign Exchange (kyats)*	*Local (kyats)*
1. CTO Central Control Board	15	2,000	
2. Typewriters	10	30,000	
3. Furniture, Alterations and Constructions	15		1,200
4. Headphones	10	1,800	
5. Tape Pullers	15	15,000	
6. Cash Registers	15	40,000	
7. Addressograph Equipment	15	2,500	
8. Motor Cycles	10	7,500	
9. Signal Wiring Changes	15		300
		98,800	1,500
Engineering and Contingency (10%)		9,880	150
		1,08,680	1,650
Estimated Cost		K1,10,330	

(2) *Annual Costs*

(i) *Annual investment charges*

Item	*Amount (kyats)*	*Rate (%)*	*Charge (kyats)*	
1, 5, 6, 7	65,450	4·634	3,032.95	
2, 4, 8	43,230	7·950	3,436.79	
3, 9	1,650	4·994	82.40	
				6,552.14

(ii) *Maintenance and Operating Costs*

Item	*Amount (kyats)*	*Rate (%)*	*Charge (kyats)*	
1–9	1,10,330	8·0	8,826.40	
				8,826.40

(iii) *Administration Costs*

Item	*Amount (kyats)*	*Rate (%)*	*Charge (kyats)*	
1–9	1,10,330	10·0	11,033.00	
				11,033.00
Total Annual Cost				K26,411.54

(7) Recommendations

It is recommended that:

(*a*) The equipment and materials listed in 6(*b*) be obtained at once. The control board and additional circuit wiring can be made by the Assistant Engineer (Electrical) and staff. Wells for typewriters can be added to the present operating tables by any skilled carpenter.

(*b*) The addressing of message delivery envelopes be done by Addressograph (coded addresses) and by typewriter (formal addresses) to eliminate errors.

(*c*) The whole message delivery and booking systems be given the attention necessary to reduce the waste of time involved in their various functions. Cash registers in the booking office to eliminate stamps, and a few motor cycles for long-distance deliveries will help materially.

(*d*) The use of telephone and teleprinter be adopted for forwarding messages between branch telegraph offices and the CTO, to save skilled operators.

(*e*) All personnel carrying supervisory responsibilities be given indicated promotions.

(*f*) A better appreciation and understanding of the Traffic Section's problems and contributions be acquired by Telecommunications authorities.

(*g*) Telecommunications make the requisite uniform allowances to its messengers, and insist on smart appearance as well as reliable service.

i. Marine Radio Station

(1) General

The marine coastal station, XYR, operates on both intermediate and high-frequency maritime radio channels to handle shipping traffic by international agreement. It is extremely well located at Monkey Point and has all necessary shops, emergency power supplies and quarters. The station has direct wire facilities with the CTO. Traffic averages 60 to 70 messages per day. In all respects it is a well-organized and efficient unit.

(2) Location Change

An unfortunate situation has developed in that the marine station must be moved to a nearby location. This is at the behest of the Burma Navy because the station is within its restricted area. Another solution to this problem should not be too difficult to find, and should be sought since moving involves a most unproductive use of men, money and materials at a time when all available resources are needed in other communications areas for providing the basic rudiments of a system. It is estimated that this move will cost K13 lakhs, and may require two years.

(3) Possible Solution

Since Telecommunications has the experience background for conducting this service, it is recommended that the function remain in Telecommunications organization and not be transferred to the Navy as an alternative to moving. Instead, it is suggested that the Telecommunications staff at Monkey Point be made a naval reserve unit. This would facilitate transfer of the control of shipping to the Navy in time of national emergency as is the usual practice, and would obviate interference with peacetime operation by Telecommunications' civil organization at the present location.

(4) Recommendations

It is recommended that the plan for moving the station be postponed while the whole matter is reviewed at high levels. If it is finally decided that the station's location is detrimental to the Navy's effectiveness, the actual moving should be postponed until a time when Telecommunications has fewer construction rehabilitation commitments.

3. ORGANIZATION

a. General

The personnel and their functions within a telecommunications organization lend themselves nicely to division into groups concerned with engineering; plant installation, maintenance and operation; traffic handling; commercial acitivities; and legal matters. This grouping has been found to have optimum efficiency as operations increase in size and complexity. In the Burma Telecommunications Department, the traffic and plant details are nearly complete to the extent permitted by equipment, standards and policy. Legal problems are arising only in radio regulations. Commercial activities, although to some extent organized and reduced to routine, are not briskly pursued. These weaknesses require prompt attention, but are of minor consequence compared to the critical need for engineering.

b. The Present Situation

As presently constituted and staffed, the Telecommunications organization cannot cope simultaneously with the problems of new services, rehabilitation, expansion and day-to-day operations. Rehabilitation and expansion programs are developing very slowly. Maintenance is badly hampered by inadequacies in manpower, stores and departmental standards. The lack of specification engineering leaves too many technical decisions to sales personnel. As operations increase in size and complexity, the need for engineering specialization becomes more pressing.

c. Limited Engineering Resources

Telecommunications for all its wide technical responsibilities has but two college-trained engineers, and these are without broad experience. Others holding engineering positions achieved the rank by virtue of selection, seniority, service or Public Service Commission examination. This meager technical staff is insufficient for an organization of this type. Former Posts and Telegraphs service has provided excellent training in administration and discipline. While there is room for wide application of those traditions in today's organization, formal engineering training is a basic requirement for successful operation in the complex field of communications-electronics. It is no personal reflection on partially trained men that they are unable to fully discharge responsibilities beyond their grasp, or to operate in fields for which they are neither trained nor experienced. This condition can be permitted to continue only at the expense of the country's welfare.

d. Applications Engineering Required

Hard pressed to furnish simple communications circuits, Telecommunications' greatest deficiency is in the field of "applications" engineering. Men with vision are needed who know enough about communications technology to analyze current problems in economically and technically sound detail. Such engineering involves all of the elements of planning and implementation so that ends and means are maintained in perspective.

(1) Remedial Action

Plant operations, too, require certain engineering skills to assure optimum system performance. Administrative and training responsibilities must also be recognized. There is a real danger in permitting an employee to hold the title and bear the responsibility for engineering, yet to perform only routine administrative tasks. There is evidence that this situation, an inheritance from the time when communications systems were simple and required little technical background, has long frustrated whatever rehabilitation plans were made. To correct this situation, the Ministry should promptly grant to its engineers the authority and responsibility to develop and introduce needed technical improvements.

e. Radio Section Reorganization

Of all the groups within the Department, the radio branch has the greatest number of pressing projects. These are of a nature to require considerable engineering effort over some period of time.

(1) Engineering-planning

With Telecommunications' most experienced radio engineers located in and about Rangoon, committee engineering-planning action on projects appears feasible. If "doubling up" in this manner does not achieve the desired end, these officers should be detached from present duties, and assigned to operate as an engineering-planning group until the projects are completed. By that time, with the emergency over, future engineering tasks can be reliably anticipated and steps taken to meet them.

(2) Operations

(See also Interim Report, page 278). From its inception, the radio division has made an all-out effort to maintain itself as a separate entity within the Department. Consequently, all matters relating to radio working on any organizational level must be referred to Rangoon for action. This has amplified administrative and personnel problems at the expense of engineering effort, to the over-all detriment of the Department. The feeling that radio operation, because it requires specialized training, cannot be administered through ordinary channels has no place in today's philosophy of cooperation. Technical matters such as design, installation and maintenance of radio circuits are natural responsibilities of the Radio Division, but operation, disbursements and discipline are matters better handled by the departmental subdivisional officer. If this were recognized, there would be no occasion for such jurisdictional friction between the subdivisional officer and the radio-station supervisor as has occurred in some districts. If purely administrative routine is handled through regular channels, the Divisional Wireless Engineer will be able to devote more time to important technical matters.

f. Telegraph and Telephone Planning

Because of engineering inadequacies and perhaps hesitancy inspired by the haste to build h.f. radiotelegraph stations, line and office rehabilitation is not showing healthy progress, even at the planning stage. The main stumbling block is, of course, security; another is inadequacy of stores; and yet another is staff limitations. The most serious difficulties, however, are the absence of a firm policy for re-establishing the all-important lines system, and the lack of a plan for its implementation. Granted that many areas are yet untenable for lines, definite planning should be completed and steps taken to procure the needed material against the day when it can be used.

(1) Centralized Effort and Responsibility

Preparation of an integrated "lines" plan is a task of some magnitude. At the moment, plans, projects and operations requiring contributions from more than one group are retarded by disagreement and misunderstanding. To meet this challenge with the action it so richly deserves, Telecommunications must abandon the piecemeal treatment it is receiving at subdivisional and divisional levels, and make centralized lines planning the sole responsibility of an experienced lines and carrier engineer.

(2) Action Required over a Wide Area

The following items deserve much fuller treatment than they are now accorded:

(*a*) Modernizing standards and developing specifications.

(*b*) Analyzing sources of supply, acquisition and stocking of tools, material and equipment.

(*c*) Ascertaining damage to alignments, and determining clearing required.

(*d*) Checking the conditions of, and planning the utilization of carrier equipment now held in stores.

(*f*) Reclamation of used line and exchange material.

(*g*) Expanding service by new lines and larger exchanges.

(*h*) Improving cost analyses, and modernizing unit-cost figures.

g. Pertinent Considerations

For maximum accomplishment in this emergency situation, officers on special engineering assignment should report, as directly as possible, to the Director's office. Frequent progress reports should be circulated to interested officials to keep them informed of project status, and to enable them to plan their own contributions for greatest effectiveness. Requisite statistical, clerical and drafting facilities must be provided for these priority operations. It is assumed that large-scale maps will have been prepared to portray clearly the details of active circuits and circuits for rehabilitation (see Section 8). Heed must be paid to the irreducible intervals required for financial approvals; authorization requests must be filed at the earliest possible moment that accurate planning will permit.

h. Evolution of an Engineering Department

For the effective functioning of the natural stimulus of competitive operations, the trend should be away from having a single organization do the planning, engineering, purchasing, installing, operating and evaluating of any particular service within the Department. The abuses of such a system are that new services, modernization, expansion and efficiency can be suppressed to avoid additional responsibility; mistakes are seldom corrected; and poor performance can be disguised. Thus, for substantial reasons of economy, efficiency and policy, the most urgent organizational change should be the isolation and centralizing of the engineering-planning functions for the whole Department.

i. Radio Regulatory Obligations

(1) General

In the field of international and treaty agreements with other sovereign powers, Burma is a member of the International Telecommunications Union, and adheres to the stipulations of the Atlantic City Convention (1947), to which she is signatory. The actual implementation and enforcement of the various regulations on the country level is the responsibility of the Department of Telecommunications.

(2) Department Activities

In actual practice, the Radio Divisional Engineer handles the details. These, when properly executed, amount to a large responsibility and require considerable time and staff. The most important function is the arrangement for frequencies with ITU, and assignment to the various users within Burma. Examinations for commercial and amateur radio operators as well as the licensing of radio transmitters must conform to standards set by international agreement. Routine shipboard radio inspections are made to enforce international safety-at-sea regulations in respect to operators and equipment. And to all of this has been added the licensing and policing of broadcast receivers. Representing Burma at world and regional telecommunications conferences is another important function.

(3) Frequency Allocation

With over 80 end-uses of radio recognized by international authorities, the general problem of frequency allocation becomes a most urgent reality. This is further complicated for Burma by the proximity of radio users who are not bound by treaty to observe the rights of others in the matter of radio frequencies. Optimum utilization even within the country is no academic matter, and requires the close attention of competent radio engineers. The magnitude of this task is brought into focus by remembering that the radio spectrum's frequency limits have a ratio of 10,000,000 to 1, while that of the optical spectrum, for comparison, is but 2 to 1.

(4) Further Requirements

Regulations concerning frequency stability, channel occupancy, standards of fidelity, noise, distortion and similar items are enforceable in conformance with treaty agreements. This function requires quality radio engineering and the laboratory facilities to permit the necessary measurements. Telecommunications has not yet been able to accomplish much in this connection.

(5) Organizational Change Indicated

In the scramble for frequencies, one organization may fare better than another. Consequently, it is reasonable that Telecommunications, the biggest user of frequencies, should not have the responsibility for assignments to itself as well as to others. There must be strict impartiality in the allocation of frequencies just as there must be facilities for regulating and controlling radio communications. The increasing importance and urgency of the matters outlined above, and the inability of the Department of Telecommunications, as presently constituted, to furnish the required services seems adequate reason for at once making a basic change to bring Burma's organizational structure into line with that of other countries.

(6) Details of New Organization Structure

There are many differently constituted organizations in as many countries for handling the responsibilities alluded to in this discussion. Burma need not copy the structure of any of her neighbors, but, to meet her own needs, can build her own along the following lines:

(*a*) The organization for control of the use of radio communications should be removed from the Telecommunications Department, but constituted by law within the Ministry of Transport and Communications.

(*b*) It should be headed by a competent engineer, at divisional rank, who has had an opportunity to study at first hand, the Federal Communications Commission of the United States and the International Telecommunications Union, Geneva.

(*c*) It should be staffed with qualified personnel to meet satisfactorily the many and varied demands made upon it.

(*d*) It should be equipped with tools and instruments including precise frequency standards and measuring instruments, distortion analyzers, field strength meters, and other conventional electronic laboratory equipment.

(*e*) It should have an adequate appropriation to cover its examining, inspecting, policing and advisory functions.

(*f*) It should represent Burma at international and regional telecommunications conventions with technical competence.

(*g*) It should submit a comprehensive annual report shortly after the end of the fiscal year.

j. Director's Staff Assistants

(1) Present Areas and Duties

The Organization Chart shows two personal assistants to the Director, Telecommunications, in the areas of engineering and traffic, respectively. In actual practice, their duties are largely routine administration, often on seemingly subordinate levels. However, with the recent appointments of a Deputy Director, and a Divisional Engineer, Rangoon Telephones, it is possible that the engineering assistant can now function with the Director to provide liaison for better handling of technical matters between the various groups and divisions. At the same time, the responsibility for commercial matters in respect to the Rangoon telephone system will be transferred to the Rangoon telephone division so that the traffic assistant can concentrate on domestic and foreign telegraph traffic problems. The present assistants, therefore, less encumbered by office routine, should be able to contribute much to the huge rehabilitation program facing Burma Telecommunications.

(2) Additional Areas Desirable

There are areas within the operation of the Department to which additional personal assistants could be assigned with advantage, at least until operations reach a more satisfactory level. It is believed that the qualified personnel for these posts can be found within the Department.

(a) **Finance and accounting.** A financial assistant should be responsible for publishing promptly a monthly statement covering all operations. In addition, he should channel to all departments such financial advice and information as required. Information necessary for an annual report (none has been published by Telecommunications since the war) should be abstracted from these statements and an accurate report forwarded to the Ministry promptly at the end of the fiscal year. Improvement in timing is important since it is noted the financial review of the Department's 1950–51 operations was not available until February 1953, and not corrected until April 1953.

The accounting-statistical procedure should be strengthened through the use of bookkeeping machines, This should receive responsible study and action in the very near future. The preparation and standardization of departmental forms should be accelerated.

(b) **Personnel.** Too much of the time of the Department's chief executive has been absorbed in personnel problems. There is a very definite need for a skilled personnel officer to take charge of routine personnel affairs, to maintain the pertinent files, to prepare the necessary reports and to interpret departmental policy.

There is also a need for a non-partisan house organ or departmental news periodical. Telecommunications personnel in the districts as well as at headquarters frequently ask for information as to what others are doing. Such a periodical published on a modest scale (Interim Report, page 285) should materially improve the spirit and unity of the Department, and could be made the responsibility of the Personal Assistant, Personnel.

(c) **Training.** Training of Telecommunications Department's workers is needed at all levels in theoretical and practical matters both to improve daily performance and to provide a systematic prerequisite for promotion. There is considerable remedial work to be done in establishing and strictly adhering to departmental standards, to say nothing of the need for upgrading personnel to higher technical responsibilities. At the present time, the traffic section is conducting a training class for landline radio operations. However, there should be authorized a complete training program which would serve all divisions of the Department, meeting as many needs as necessary. The addition of a qualified Personal Assistant, Training, provided with necessary equipment and facilities to arrange and manage training programs of all kinds would be a logical and much-needed change (see Section 5).

k. Recommendations

While there are many items requiring corrective action within the area of organization, only the most pressing are considered at this time. It is recommended that:

(1) An engineering group be established within the radio section as a part-time committee to plan for the more pressing expansion activities on a scale more appropriate than thus far undertaken. As soon as the technical manpower situation permits, this group should become part of a full-time engineering section within the Department.

(2) An engineering group be established to prepare detailed plans for the practical rehabilitation of Burma's landline system and the related expanded telephone-telegraph working. The engineering development of economical and satisfactory service in the lines system must be given emphasis commensurate with the huge investment.

(3) All telecommunications engineering recommended above ultimately be combined into a single competent engineering-planning section to serve the whole department.

(4) A radio regulatory body, with such duties and responsibilities as have been outlined be established outside the Department of Telecommunications but under the parent Ministry.

(5) To minimize departmental reorganization and yet provide essential services, personal assistants to the director be added in the areas of personnel, training, accounting and finance.

4. PERSONNEL—MANAGEMENT HANDICAPS

a. General

The Department of Telecommunications because of its close relationship with the public is the target of constant criticism. Since the operation of the organization is exactly what its members make it, considerable study is warranted of such matters as personnel procurement, administration and performance, all basic to effective management.

b. Telecommunications Enquiry of 1949

The allegedly unsatisfactory performance of the Department, especially the Rangoon telephone system, provoked a full-scale Government investigation. Broad charges of inefficiency and incompetence placed the organization's administration and operation in a very bad light. Without repeating the criticisms of the report, it may be said that considerable remedial action was indicated. However, after four years it would appear that no sustained action has been taken or is planned.

c. Loss of Leadership

Many of the weaknesses of the Telecommunications staff and its operations may be attributed to the loss of trained and experienced personnel as a result of the Burmanization Act, coupled with the depredations of dacoity and insurgency. Newly promoted officials placed in high posts and hampered by insecurity and meager job knowledge could contribute little to running the organization. With supervisors unable to impart thorough knowledge of procedures and standards to their organizations, the level of performance deteriorated. Average acceptable job standards ceased to exist. Although there is now encouraging evidence that the general situation is improving slowly, exemplary supervision bolstered by training programs under a firm departmental administration is needed.

d. Interference

A serious manifestation of the breakdown of leadership and authority is the prevalence of disregard for the established channels of authority. No program can be consistently or effectively pursued if subordinates can regularly evade or alter assignments by direct solicitation of authority higher than their immediate supervisors or if higher authorities persistently ignore responsible supervisors in giving instructions directly to those supervisors' subordinates. Errors of omission and contradiction are inescapable under such conditions and the ignored supervisors are rendered unproductive. It has been observed that in the day-to-day operation of the Department, the Director's office is frequently bypassed in both directions to the extent that the Director is left ignorant of the exact status of some projects. This situation should be corrected by the immediate adoption and promulgation throughout the organization of a carefully prepared statement of the mutual obligations and responsibilities of supervisors and their employees, to include such matters as support of subordinates' decisions made in the conscientious discharge of delegated responsibilities, encouragement of immediate supervisors, delineation of rights of appeal to avoid abuses, obligations of supervisors to accept responsibility for subordinates' mistakes but to give credit for subordinates' ideas and performance, and respect for channels of authority.

e. Morale and Effort

Although government service in this area of the world has been traditionally performed with competence and pride, the general impression gained of the Telecommunications Department is not one of high spirit and morale. Some of the reasons for this lie in the unsatisfactory salary and promotion situation.

(1) Salary

Broadly speaking, the salary scale is not liberal. Private employment requiring comparable technical skills is much better paid, as attested by the experience of those having left the Department. It was believed that this situation would be corrected to some extent when the Wider Pay Commission's recommendations were implemented. The failure of this measure has sacrificed a powerful incentive. There is little logic in importing precision communications equipment for upgrading the service, if the technicians are paid so little that the circuits cannot be maintained. Technical skills should receive compensation commensurate with the effort, intelligence and initiative required to develop them.

(2) Status

The pension provisions which are an attractive feature of government employment are counteracted by procrastination in confirming employees, even after several years of continuous service. While this occurs at all levels, the most shocking example involves the telephone operators. Of the 352 employed in Burma, only about 65 are confirmed at the time of this writing. Employees cannot be expected to do their best work, year after year, without even the minimum recognition established by regulations.

(3) Allowances

Telecommunications is a far-flung organization. Its employees are posted to all sections under a variety of conditions ranging from excellent to very poor. Yet the various allowances designed to recognize and equalize these situations in prewar days have been discontinued. This has resulted in detrimental maneuvering of all kinds to secure assignments to the better posts and to avoid unpleasant posts. Even though unintentional, assignments under these conditions have a discriminatory aspect which lowers morale and provokes dissension. Inequalities arising from matters of leave and quarters are equally disturbing. An equitable policy is long overdue.

(4) Promotion

Much of the Department's inefficiency, waste and poor service stem from emphasis on form rather than substance, both in the selection of personnel and in the performance of daily duties. Merit and ability should be recognized before seniority in achieving promotion. Since service time can be totaled with great accuracy and little effort, as compared to professional competency, seniority has become a criterion of exaggerated value. This emphasizes the need for departmental examinations as partial criteria for the promotion of those with the capacity for greater responsibility.

f. Remedial Action

As the value of competent and contented manpower has crystallized in the last few decades, increasing attention has been paid to personnel matters. Low-salaried employees are not economical when productivity is evaluated. The countenancing of procedures which permit a favored group or individual to wield power unsupported by ability and productivity is unacceptable in progressive concepts of labor relations. Unfair and unethical practices soon result in low morale and inferior production. To correct such deficiences, the various remedial actions that have been suggested must be initiated and pursued by elements of the staff sufficiently high to produce thorough and lasting results.

g. Unionization

The All-Burma Telecoms Workers Union has 2,500 members, about 80% of the non-gazetted employees. In all, there are 13 locals with headquarters in Rangoon. Delegates meet annually to formulate policies for improving the status of telecommunications employees. Since special emphasis has been placed on such matters as an enhanced salary scale, re-establishment of allowances to adjust inequalities of assignment, and prompt confirmation action as outlined in departmental regulations, it would appear that the organization is concerned with logical and legitimate goals.

h. Recommendations

It is recommended that:

(1) Departmental regulations covering administrative procedure be impartially and vigorously enforced, especially in the areas outlined. Where these regulations are found to be weak or unsuitable, appropriate changes must be made. Responsibilities and obligations of leadership should be emphasized.

(2) A more rigid interpretation of job quality standards be imposed by high authority.

(3) The entire salary scale be reviewed in the light of findings of the Wider Pay Commission.

(4) The incompetent and inefficient be removed by the procedures set up in the regulations. The seriousness of harboring or protecting such individuals must be impressed upon all supervisors.

(5) The necessity for and the importance of training, and personnel administrative programs be recognized by detailing responsible officers to these functions (see Organization, Section 3).

(6) A procedure be set up for objective evaluation of all qualifications pertinent to promotion in addition to the facts of previous service. Technical qualifications must be established by written examination and performance within the Department before confirmation on any level.

(7) More attention be focused upon improved morale by appropriate and inevitable recognition of both superior and inferior performance.

5. TRAINING

a. Need and Status

Telecommunications' need for training is acute, but the urge for self-improvement that sparks the necessary individual effort is noticeably lacking. Suggestions that training courses might be necessary have not been generally welcomed. To overcome misunderstanding and reluctance, both a full appreciation by supervisors of the mechanism and results of training and a system of recognition of trained employees must be developed. Everyone seems satisfied enough with status quo to wait for someone else to get something started. In terms of success, they have gotten out of their training program about what they have put into it.

b. Motivation

Before any general training program can be successful, there must be genuine willingness on the part of the trainees to do the extra work involved. This attitude of willingness will be present only when the trainee can visualize a reward for completion of the course. Suitable incentive may be promotion, increased salary, improved status, or easier methods of performing the job, and must be of demonstrated value. The need for training in order to qualify for performance tests and examinations will also provide motivation when these procedures have been established. If definite courses are known to be pre-requisite for certain jobs, and are proven genuinely valuable, there will be no shortage of willing trainees.

c. Some Training Successes

(1) Radio Operators

Telecommunications is conducting an operator-training program in which selected candidates receive a stipend while undergoing full-time training. Only in this manner have they been able to keep abreast of the operator demand for the expanding h.f. radio network. Two instructors are employed, one conducts the code instruction (English and Burmese) and message-handling procedure, while the other teaches some electrical and radio theory. There is no practical laboratory instruction in the latter section, although the students are sent to the Central Telegraph Office for experience prior to graduation. The course requires approximately six months, and has graduated 22 to date. There are 27 enrolled.

(2) Line Staff

A few weeks of training in practical and theoretical communications practices has just been completed with a group of linemen. It was said to have been mutually beneficial to both employees and employer. A formal report with details and an evaluation of this venture should be prepared and given wide circulation.

d. Implementing a Training Program

The Director of Telecommunications should establish the training program, and utilizing his Personal Assistant, Training, should so plan that all personnel are reached to the optimum degree.

(1) Length of Program: Cost

The direction the training program takes, and its magnitude, will depend on the communications media adopted by the Department, and upon the reservoir of trained people available. The following figures are based on a three-year intensive schedule followed by contraction to an irreducible minimum:

Teacher and Librarian (salary and honorarium)	K20,000
Furniture	K10,000
Instruments, Tools, Equipment*	K25,000
Books and Magazines	K3,000
Paper, Printing, Incidentals	K2,000
Total	K60,000

* Can also be used in Telecommunications Shop.

(2) Evening Classes

Evening courses can often be conducted to advantage. If the material is worth while and the men are willing to devote an evening or two a week to their own betterment, the movement should gain momentum. For a modest honorarium, experienced personnel can be persuaded to take over instructional responsibilities in their particular field. Any foreign engineers available to the Department would probably wish to participate in the training program at appropriate levels. As the saying goes, "It will be very easy to separate the men from the boys" when it comes to a modicum of sacrifice for self-improvement.

(3) Levels and Recognition

Supplementary instruction for those holding the higher posts requires the more urgent attention. Since each individual involved will have some valuable experience to share, such training will probably be most effective if approached from the conference standpoint. Tact, dignity, yet firmness must characterize this venture since the objective is to increase the contribution of individuals who have experienced rapid promotion and who may not take kindly to a suggestion that further training is either appropriate or necessary. Most requests for technical instruction come from employees at the intermediate levels. For these interested and ambitious individuals who are already impressed by the great deal they have to learn, the application of the conventional principles of technical and vocational training will assure most satisfactory results. At lower levels, training is chiefly concerned with imparting job skills based on departmental specifications. Since these ranks are most important to the functioning of the system and have provided some of its most dependable officers, there should be enough continuity of pertinent related material to provide a useful and strong foundation for future development.

Attendance and effort must be recognized and rewarded. This requires adequate record-keeping, and a stricter discipline with respect to attendance and preparation of assignments than is in evidence in day-to-day operations. A frank and objective appraisal of the individual's accomplishment must become a part of the departmental permanent record.

(4) Technical Library

To supplement any worth-while program, a well-stocked library must be available. Most technical organizations throughout the world have flourishing libraries equipped with the latest professional periodicals and books. Telecommunications attempted such a project but abandoned it because of staff misuse. This service should be reopened under the supervision of a librarian who would perform the usual supervisory tasks, besides opening the library at specified times. Any future misuses should be corrected by appropriate supervisory measures rather than by closing the library.

e. Engineer Recruit Training

(1) General

Local engineering college graduates, as well as state scholars who are recruited by Telecommunications must spend a considerable period of time in the various phases of the Department's activities before they know enough about operations to bear responsibility in supervisory posts. During this period, the recruit's potential value to the service can be ascertained quite accurately. If there is reasonable doubt of satisfactory adjustment on the part of the apprentice engineer at the end of his experience-training period he should be dropped forthwith.

(2) State Scholars

The program for bolstering the engineering nucleus of Telecommunications is enhanced by the training of several state scholars in the United States. Upon graduation from engineering colleges they will pursue a two-year work-study program with appropriate communications companies before returning to Burma. The practical application of modern trends of carrier telephony-telegraphy, teleprinter circuits, and various types of radio working and automatic telephony has been specified for these two-year tours. With respect to the return of these young men, one particularly serious pitfall must be avoided. This is the danger of a too rapid assumption of responsibility without sufficient personal knowledge of actual operating conditions in Burma. This can be avoided by a systematic rotation of the students through the actual operating jobs requiring them to personally perform these duties. Such a program is now being considered.

f. Recommendations

It is recommended that:

(1) A training program be established under competent direction to meet the various technical requirements of the Department. This should include both day and evening courses.

(2) This training program utilize tried and accepted methods of technical and vocational training.

(3) Promotions without appropriate theoretical and performance examinations be eliminated.

(4) A well-stocked and properly staffed professional and technical library be established at once within the Department. Further, that the services of a competent librarian be furnished.

(5) Enough money be appropriated for the training program to provide the necessary training aids and furniture for a functional classroom. A modest honorarium should be offered staff members who participate in instruction.

(6) A rigorous local experience-training program be required for all engineering recruits, and that permanent employment depend largely on ability demonstrated therein.

6. FINANCIAL MATTERS

a. General

The Department of Telecommunications is a revenue-earning organization which turns over its earnings to the Government, and is in turn supported by direct annual appropriations. Review of the fiscal year 1950–51, recently released, shows the Department operating at a substantial profit. Figures for 1951–52 have not been finalized.

b. Organization

(1) Responsible Head

The Director bears the responsibility for:

(*a*) Maintenance of all accounts in accordance with regulations.

(*b*) Submission of accounts to the Comptroller, Posts and Telegraphs, monthly.

(*c*) Collection of all revenue.

(*d*) Estimating revenue and expenditures in preparing the annual budget.

The Director and lesser officers are guided by the schedule of financial powers in the matter of expenditures beyond which governmental sanction must be obtained. The entire budget control rests with the Director.

(2) Staff

Accountants and clerks handle the details under each account head, and prepare various financial reports for the Ministry and for the Comptroller of Posts and Telegraphs accounts.

c. Comptroller of Posts and Telegraphs Accounts

This post is directly under the Accountant-General of GUB, and is responsible for auditing the accounts submitted by various officers, as well as for keeping the official account for the Department. He renders to Government, monthly, the actual expenditure of the Department, and keeps the Director informed of sanctioned allotment expenditures. He also checks the propriety of financial reports and their adherence to regulations.

d. Annual Budget

A budget section of three accountant-clerks collects information from all branch heads, and consolidates this into a statement which the Director submits to Government in anticipation of the revenue and expenditure for the next fiscal year. This budget finally reaches the Finance and Revenue Ministry which checks and trims it as deemed necessary. It is then reported back to the Director who notifies those involved of any reapportionment.

e. Annual Report

The Comptroller periodically submits a report to Government covering Telecommunications' financial status. In addition, the Director submits a review of the financial statistics for each year's working. However, since the Department has enjoyed autonomy, a conventional annual report has not been published. Prewar, an excellent review of the Department's fiscal activities was published, providing not only financial facts but information covering new services, expansion, and various items of interest. It is believed that there is enough of instructive and informative value in Telecommunications' activities to justify reviving the practice.

f. Financial Summary

The figures in the accompanying table were furnished by the Department of Telecommunications, and are included to illustrate the magnitude of financial operations.

g. Depreciation

A sum of money is deposited yearly in the Renewal Reserve Fund against replacement of capital assets. The amount to be deposited is determined by the Comptroller for a three-year period. The balance in this funds bears interest to the Department.

h. General Accounting

From the brief study made, it is believed that a general overhaul of the accounting methods as a whole is necessary to bring them into line with commercial practices. As the accounts are now prepared it is extremely difficult and time-consuming to separate the activities of the various services to permit examination of any one aspect of their working. For example, the cost of maintaining telephone service in any one community cannot be clearly distinguished. Simplification, greater accuracy and much greater speed in all procedures are essential. This is another area within the Department where machines rather than increased manpower are required.

i. Recommendations

It is recommended that:

(1) An annual report similar to that used before the war be published shortly after the close of each fiscal year.

(2) Mechanized accounting be adopted to enhance the speed and accuracy of the accounting function.

(3) A Personal Assistant, Finance, be added to the Directors' staff (see Organization, Section D-3-j).

(4) The Personal Assistant, Finance, selected because of ability and thorough experience in Burma Telecommunications accounts, be sent to London to study the modern accounting methods of the British Post Office. The practices of the two communications

FINANCIAL STATISTICS

Account	*1945–46* *(K)*	*1946–47* *(K)*	*1947–48* *(K)*	*1948–49* *(K)*	*1949–50* *(K)*	*1950–51* *(K)*	*1951–52* *(K)*
Revenue	5,34,540*	32,83,022	57,32,438	42,73,753	44,68,011	60,73,860	74,36,875
Working Expenses	— †	—	56,51,482	48,11,251	50,15,830	51,26,040	— ‡
Net Income	— †	— †	80,956	–5,37,498	–5,47,819	9,47,822	— ‡
Capital Outlay	15,17,367	15,52,048	12,59,125	30,67,314	4,22,164	4,26,482	2,15,909
Stores Suspense	31,47,604§		–1,00,512	1,56,839	–3,97,233	3,93,148	— ‡

* Less telephone revenue; figure unavailable.

† Posts and telegraphs accounts not separated.

‡ Figure not yet available from Comptroller of Posts and Telegraphs.

§ Exact breakdown figures awaited from Comptroller of Post and Telegraphs.

The progressive capital outlay to the end of the 1950–51 period is K1,51,04,181; and includes K36,58,503 for assets taken over by the administration on January 1, 1946.

organizations have so much in common that this should be done without further delay.

7. RATES AND CHARGES

a. General

Burma Telecommunications has operated at a profit for the past two years. This cannot be attributed to good management, but is rather a result of exorbitant telephone rates and miserly repair and maintenance spending. A well-managed and integrated telecommunications system should pay its way without unreasonable costs. With service costs based on operating costs, there must be periodic examinations to check that a reasonable balance is maintained. When the administration is charged to conduct its working as a commercial enterprise, it must regulate its affairs to stay out of the red.

b. Telephone

(1) Present Unsound Basis for Charge

More people use the telephone than all other telecommunications media combined. Invariably, the telephone service is the most lucrative of combined operations. The better and more extensive the service, the cheaper it becomes if the quality of engineering and the efficiency of operations are high. These considerations highlighted the high rates and poor standards of Telecommunications' limited service. The combined local and trunk flat-rate scheme is faulty since it is based on two unsound premises, the assessment of equal charges for unequal services (since all subscribers pay for trunk operations whether or not available or used), and the assessment of an annual charge much higher than service cost plus a reasonable margin of profit.

(2) Local Service

Under present exchange conditions, and until automatic working is a reality, flat base rates for residential and business usage should be employed. With automatic switching, call meters can be employed to assess the costs more fairly to those who use the service most. The importance of careful, accurate cost accounting cannot be over-emphasized in the compilation of the subscriber's annual charge.

(a) **Rangoon system income statistics.** It is apparent that the greater the number of telephones per unit of population, the better and cheaper the service can be. At the moment, the Rangoon telephone system is carrying many communities which have so few subscribers that the community accounts show deficits even at the K600 annual rate. For the fiscal year 1951–52, Telecommunications extracted the following information from the South Burma Division's statistics:

Annual Income	K18,76,204
Annual Cost of Operation	K3,75,275

About K11 lakhs are outstanding in uncollected revenue. These arrears are said to be chargeable largely to government departments and ministries. The annual telephone directory, although supported by paid advertising, is sold for K3 per copy.

(3) Trunk Lines

These lines provide the medium for interconnections between exchanges. The cost of a line is proportional to its length. To be fair in setting scales for their use, zoning arrangements are universally resorted to. Yet in Burma trunk calls are allowed without further charges beyond the annual fee of K600. When trunk operation is restored on a large scale, zone rates should be established. Toll-ticket meters should be used on the boards to speed up error-less recording of call data for billing purposes. Night and holiday preferential rates should be introduced to encourage use of the facilities outside of peak daytime periods. The schedule of rates must be calculated carefully, and will probably require frequent adjustment during the three- to five-year period following trunk rehabilitation. A sample zone scale is shown on the next page to illustrate the typical order and trend of charges.

(4) International Radio Telephone

Flat rates are used for internal connections on overseas calls to facilitate the calculation of charges. As in the case of all trunk operations, greater use brings about cheaper unit service. The rates are set by international agreement at levels consistent with an efficient service.

(5) Billing

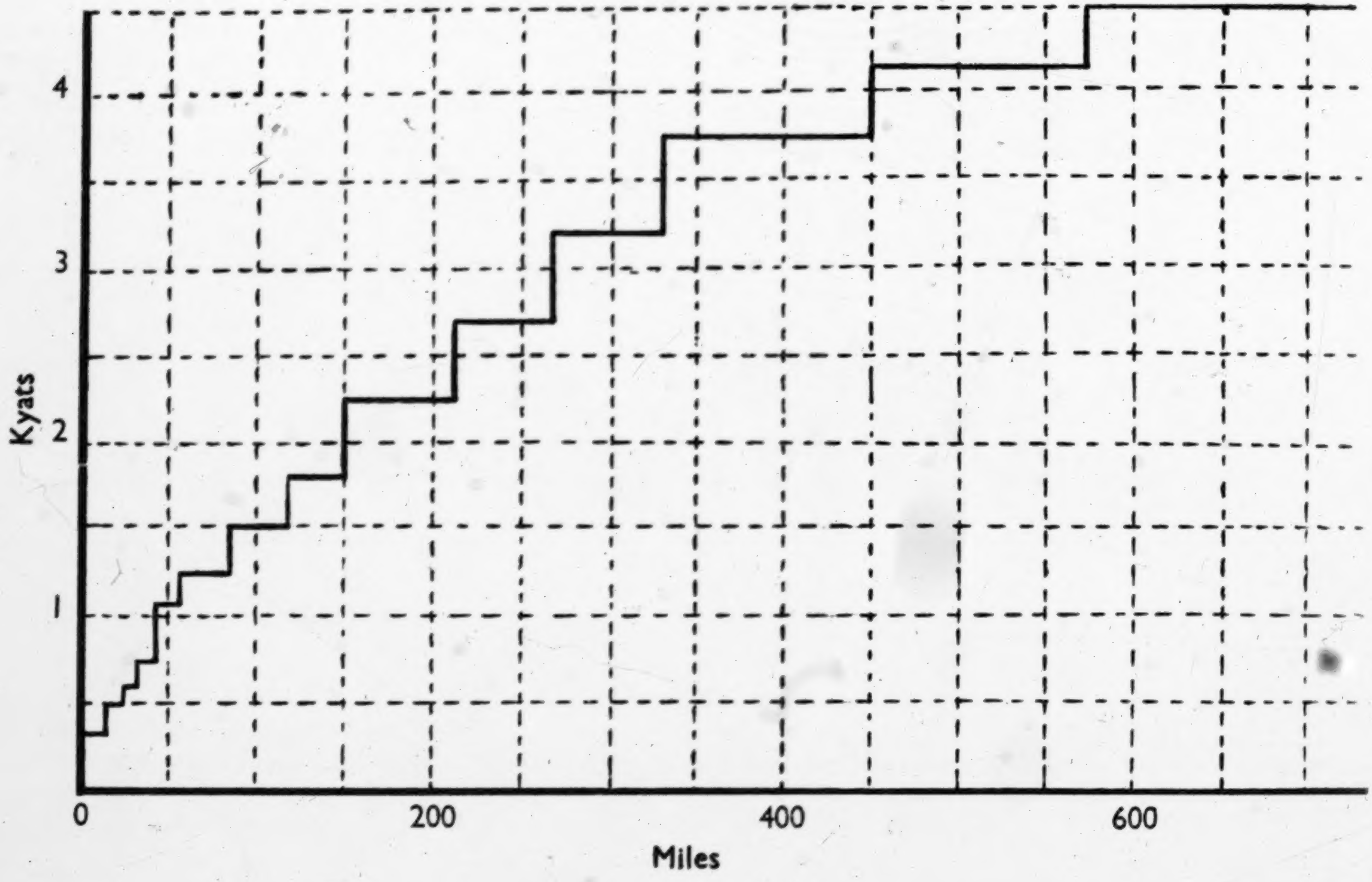
Telephone revenue, in most countries, is collected monthly or bi-monthly. Billing machines are used to record the various items on the bill form. Some progressive telephone administrations mail the toll tickets to the customer with the bill, and hold a record of them on microfilm. Special forms are used so that one section appropriately stamped serves as the subscriber's receipt.

c. Telegraphs

(1) General

In many countries, internal telegraph services have been running at a loss for several years. This limits expansion and threatens the quality of service. Since most operations involved in handling a telegram are of an individual nature, the cost is inherently high. In Burma, all inland telegrams are handled on a flat-rate basis. Consequently, the message charge rarely reflects the actual costs involved. It is said that the

SAMPLE ZONE SCALE TO ILLUSTRATE THE TREND OF CHARGES



British Post Office has not shown a profit on inland telegrams since a common rate was adopted in 1870. With the local telegraph system operating over expensive h.f. radio circuits often involving several relays, a rate schedule should be compiled to reflect more accurately the actual cost of the service. Government subsidy should only be applied to those circuits of maximum public benefit which are at the same time inherently unable to pay their own way. Zone charges should be drawn up in the same manner as for trunk telephone operation.

(2) Special Services

Embassies and business houses maintain "deposit accounts" with the Central Telegraph Office so that time is not wasted in individual filing transactions. Under the prevalent procedures in the booking office this is an important consideration (see Section E–2h–(4)–(a)). Press rates have been established, as well as a money-order service. No reduced rate services are in existence.

(3) Combined Post and Telegraph Offices

There is considerable merit in areas where the dual duties are not detrimental to each other, in combining the telegraph and post offices. The saving in manpower and establishment is nearly 50%; there should be no difficulty in keeping the accounts separated and accurately. Incentive arrangements can be made with the postmaster-telegrapher to cover the telegraphic circuit after the post office is closed. Since this type of operation proved its worth before the war, plans to abolish it in all areas of Burma must be considered extravagant, especially at this time.

d. Rate Setting

The Department of Telecommunications proposes rates and rate changes subject to approval by the present Ministry. Final approval is given by the Ministry of Finance and Revenue.

e. Recommendations

Considerable thought should now be given to setting up adequate rate schedules against the very near future when Burma's telecommunications will be fully extended. The present approach to the rate structure is both inequitable and uneconomical. It is therefore, recommended that:

(1) The traffic department gather pertinent information from other countries on zoning and rate setting for reference in preparing a schedule to submit to Government. The philosophy of charging what the

traffic will bear is as untenable for telephones as is charging too little for telegraphic service.

(2) The traffic department designate a competent person to study and handle all matters in connection with rates and charges. He must be familiar with all phases of traffic and cost accounting so that he can establish a schedule which will produce the necessary income, yet stand comparison with universal practice.

(3) Monthly telephone billing be established with adequate forms and office machines for rapidly and accurately conducting this phase of the business.

(4) Special services at appropriate rates be introduced as soon as trunk working is resumed.

8. CHARTS, MAPS AND RECORDS

a. General

Officers of an organization as diverse as Telecommunications need every type of statistical and visual aid in planning and conducting operations. Both are seriously lacking in the headquarters offices. As a consequence, the staff is poorly informed, and productivity suffers. Accurate, up-to-date information is slow in circulating to the extent that one group seems to know what the next is doing only by coincidence. When information must travel by word of mouth without substantial documentary support, rumor rapidly supplants fact. This situation can be remedied.

b. Filing

The type of folders used by the Department for filing has the serious disadvantage of deteriorating rapidly through frequent handling. Since the only index of contents is within the folder itself, unusual dependence is placed on memory as to the whereabouts of various documents and records. The storing of these folders in open cases invites loss, requires altogether too much space and contributes to untidy office atmosphere.

c. Charts

The programming of all of the Department's operations should be suitably plotted on charts so that interested and responsible individuals are thoroughly advised of current and projected affairs. This is especially pertinent to engineering and traffic activities.

d. Maps

Telecommunications is further handicapped by a meager supply of appropriately scaled maps essential for record and for the conducting of many operations. The shortage is aggravated by inadequacies in drafting and reproducing facilities. For example, the blueprinting machine is an ancient type which depends on sunlight for operation. The drafting tables are small, three by four feet, with non-adjustable tops. Map storage facilities are totally inadequate, as is bulletin posting space within all offices.

e. Recommendations

It is recommended that:

(1) A modern print reproducing machine be obtained for Telecommunications headquarters with which to provide efficient printing service for all sections of the Department.

(2) Adequate drafting tables, as well as map and chart storage facilities be provided. Drawings of these items should be prepared to permit local construction.

(3) All divisions and subdivisions provide graphic information of operations plans and progress.

(4) Drawer-type filing cabinets be provided as standard equipment in all offices of the Department.

(5) An improved and more complete method of indexing file contents be employed.

(6) The study of this phase of departmental operations be continued.

9. STORES ORGANIZATION

a. General

Telecommunications stores is responsible for procuring, stocking, listing and dispensing the materials used by the various branches of the service. Since most of this has to be imported on tender, there are numerous delays which are in part responsible for much of the Department's apparent lethargy. In this situation, there are many contributory factors that could be eased or eliminated entirely.

b. Physical Structure and Staff

The store's godowns are located in the Botataung section of Rangoon, from whence supplies are shipped to all divisions. In charge of stores operations is a superintendent who reports directly to the Director of Telecommunications. On the staff are an assistant engineer, several clerks, and the necessary stock handlers. Also at this location are the shops for minor repairs to line and radio communications instruments. Stores is a large operation and currently carries an inventory of K30 lakhs.

c. Requisitions and Sanctions

When requisitioned materials are in stock and covered by a current appropriation, the service is reasonably adequate. However, as is often the case when unstocked, material exceeding the Director's financial power of K3,000 must be authorized for purchase by Government. This procedure is required even though the appropriation for the purchase has been made in the budget, and results in serious and fatal delays. The request for sanction goes first to the parent ministry for administrative approval and thence to the Ministry of Finance and Revenue. If the request involves expenditures for a new project and exceeds a modest sum, Finance and Revenue takes it to the Standing Finance Committee for a final approval or rejection. It is not unusual for a budget allotment to expire during this process, thus requiring a new request by the very same procedure during the subsequent fiscal year. In the meantime, a price increase on imported equipment may require a supplementary allotment.

d. Further Stores Problems

(1) Superintendent's Financial Authority

The Telecommunications Inquiry Report first pointed out the clumsy business procedures under which the stores organization must function. The Superintendent has no financial authority to purchase even the smallest item. All such matters must be referred to the Director. It would appear a simple matter to arrange a reasonable latitude for the Superintendent to make small purchases without annoying the Department's chief executive with such minor details of daily operations.

(2) Government Central Stores

It is necessary to ascertain the availability of a desired article at the Government Central Stores before if can be purchased locally. Even when the article is stocked, a week or more may be required to deliver it to the Department's storeyard.

(3) Licenses

Import licenses are stipulated for materials brought into the country for departmental use. Since these must be procured before the order can be placed, considerable delay is chargeable to this requirement alone. Customs duties and handling are also applicable to these imports.

e. Superintendent's Status

Before the war, the Superintendent had an additional pay allowance of K100 per month. After independence, this was withdrawn, and the post was reduced to the same level as that of an assistant engineer in charge of a subdivision. On this basis, there is insufficient incentive for the quality of work required. The change of status long recommended should receive prompt consideration.

f. Stores Suspense Account

Materials are continually added to and withdrawn from stores. The difference in value between the amount in and the amount out is carried in this appropriate account heading. From the accounting point of view the treatment is adequate. However, the investment in this amount bears interest to Government, chargeable to the Department. At the same time, many items desperately needed on various jobs are held in stores but cannot be requisitioned because of Departmental budget restrictions. The net result finds Telecommunications paying interest on material which it needs but cannot use. A more equitable arrangement should be devised.

g. Recommendations

It is recommended that:

(1) The financial authority of the Director be increased to reduce the number of sanction requests necessary unless a much less cumbersome procedure is installed.

(2) The post of Superintendent of Stores, because of its responsibility, be improved in rank to equal that of Divisional Engineer.

(3) Business machines be adopted for improving the records and saving time and manpower.

(4) An emergency project head be set up during this period of expansion-rehabilitation to facilitate withdrawing specific instruments and tools. Some measuring instruments, in whose use technical staff should be trained, have been held in stores for years under the misguided impression that they were too "expensive."

(5) The Superintendent of Stores have a modest financial authority, subject to regular audit, for emergency purchases on the local market.

10. SUMMARY AND CONCLUSIONS

a. General

Burma's telecommunications goal must include the best features of the prewar-postwar system besides such desirable innovations as the state of the electrical communications art will permit. The long-range objective should be prompt and accurate service between the major centers with dependable, if somewhat slower, coverage of the rest of the country. The result will be a telecommunications network superior to any in southeast Asia today. To achieve this goal, the telecommunications organization must be given every encouragement and assistance in adapting itself to new methods and equipment.

b. Attitudes and Policy

Men with vision and energy are needed to plan to build and to operate this network. Economic and social policy guided by sound engineering advice must achieve the balance between need and cost. A capable engineering organization must be established to prepare detailed plans and to supervise their implementation. Appropriated money must be made readily available for the installation of new projects and for the adequate maintenance of those already in operation. Some means must be found for reducing the administrative delays in releasing appropriated funds to permit rapid initiation of needed new work and repairs. A fuller realization of the importance of communications to the smooth and expeditious functioning of every activity of the Government should go far toward mitigating some of the inadvertent handicaps to rapid development.

c. Extent of Telecommunications Coverage Recommended

Improving but uncertain security conditions preclude detailed planning in many areas, but these temporary conditions must not obscure the long-range view. Consequently, this Report, while according important consideration to the long term for general direction and guidance, has placed major emphasis on various near future projects. Once the backbone of trunk communications is established, the expansion of industry and the needs and wishes of the people will dictate further development. The end of the five-year period could and should find the following situation:

(1) External Circuits

(a) **Telegraph.** Radio teleprinters handling all of Burma's foreign traffic through the new transmitting and receiving centers which are connected to the Central Telegraph Office by multi-channel microwave circuits.

(b) **Telephone.** Radiotelephone connections to the international circuit via the India link, and possibly limited direct service to other neighboring countries on a split-schedule basis.

(2) Internal Telephone and Telegraph Circuits

(a) **VHF-UHF.** Carrying the Delta's primary and most of the secondary trunks to Rangoon.

(b) **HF.** Furnishing long-distance circuits to areas in the outlying districts over difficult terrain. Not more than 20 such circuits should be required in all of Burma.

(c) **Landlines.** Handling the Rangoon–Mandalay trunk traffic on carrier circuits, and extending in all directions (except the Delta) to provide secondary trunks and tributary service.

(3) Telephone Exchanges

Rangoon's exchange automatized, and Mandalay's expanding with C-B operation. The C-B exchange program expanding satisfactorily throughout the large communities in the districts, and the smaller communities' telephony program taking shape.

(4) Telegraph Terminals

A wide use of teleprinter in offices handling substantial amounts of traffic, and combined telegraph and post offices in remote districts where economical dependable service is required.

(5) Engineering Organization and Training

So arranged and established that the functioning of the Department affords no basis for serious criticism. This requires engineering, planning and operation along the modern efficient lines recommended in this Report.

d. Recommendations Summarized

The following is a brief résumé of the numerous recommendations offered in this Report for improving the scope of service and the efficiency of Telecommunications in Burma. Ten projects basic to this attainment are shown in Plate 7 in terms of the estimated cost and the time required for completion. It is not intended to convey the impression that these projects will achieve everything needed in an integrated system, for such is not the case. They will, however, provide the framework to give shape and strength to the structure. Details can and must be added as required and justified.

(1) Burma's Foreign Communications Circuits

Considerable expansion and modernization are necessary, and can be achieved by:

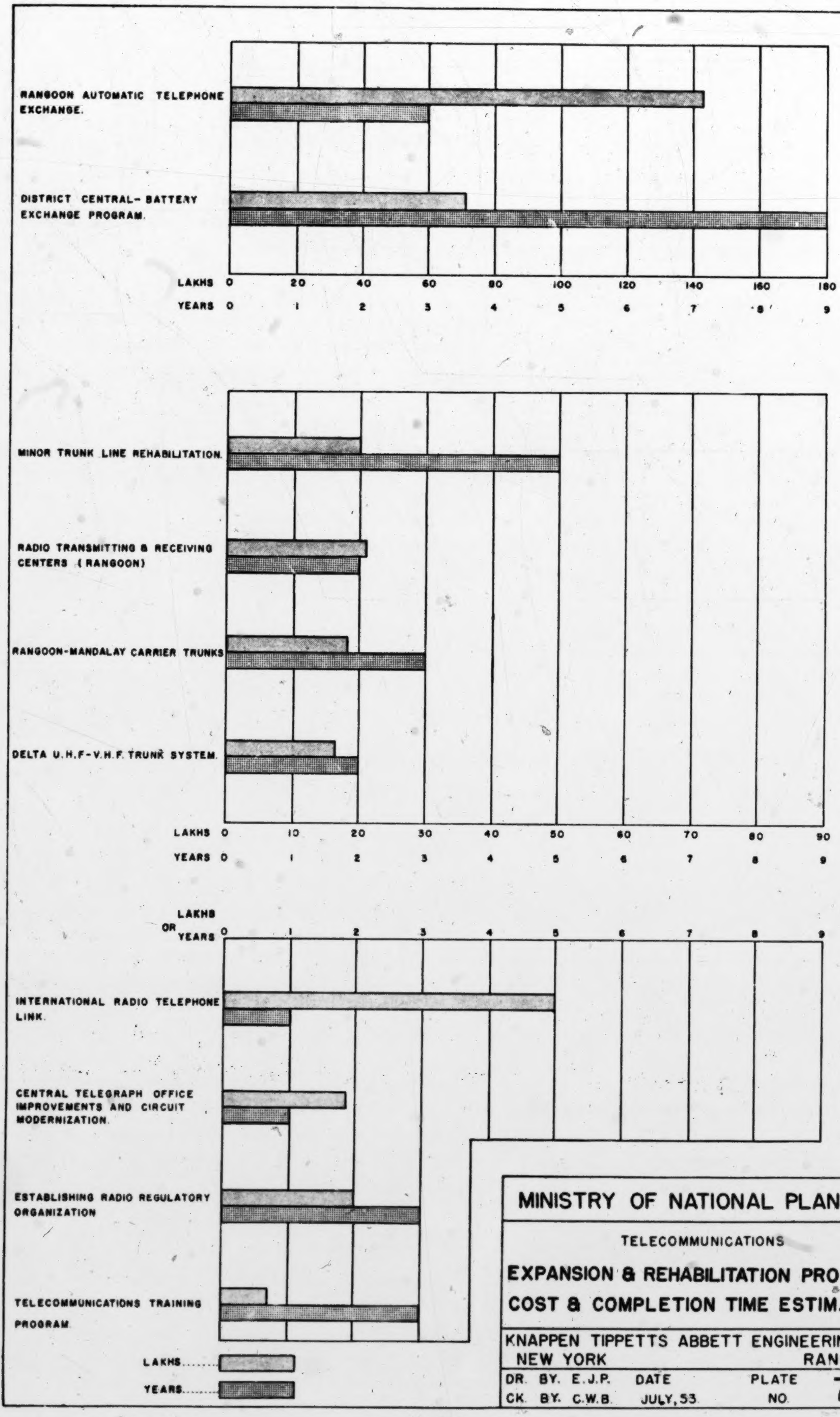
(*a*) Adopting frequency-shift keying, diversity reception and teleprinter operation on the foreign circuits.

(*b*) Shifting the receiving and transmitting stations to functional centers large enough for the requisite directional antennas, and connecting these centers to the Central Telegraph Office over multi-band u.h.f. circuits.

(*c*) Arranging with India to use single-sideband suppressed-carrier operation for the projected international radiotelephone link. Also discussing the possible use of Calcutta as a radio terminal for future Burma–India telephone and telegraph circuits.

(*d*) Considering split-schedule direct radiotelephone–telegraph operation with neighboring countries other than India and Ceylon, for improved service and reduced rates.

(*e*) Carrying out the design of buildings, auxiliaries and antennas for both the receiving and transmitting centres so that construction can start *as soon as the sites are provided and equipment available.*



MINISTRY OF NATIONAL PLANNING

TELECOMMUNICATIONS

EXPANSION & REHABILITATION PROGRAM
COST & COMPLETION TIME ESTIMATES

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. E.J.P. DATE PLATE
CK. BY. C.W.B. JULY, 53 NO. 7

(2) Communications within Burma

The present state of Burma's internal communications system (see the table entitled "Present Facilities," and Plate 1) is such that remedial action is needed in all areas. It is recommended that:

(a) **Trunk facilities.** (1) Because of the high cost and mediocre service rendered, the expensive high-frequency radiotelegraph program be curtailed to serve only those areas inaccessible to landlines.

(2) Microwave radio be utilized for the Delta primary trunk system, and the v.h.f. equipment, not yet in operation, be used for secondary trunks. Improved service and greater economies will result in these marshy areas with their numerous river crossings.

(3) Serious planning for rehabilitation of the Rangoon–Mandalay carrier routes be undertaken at once so that unstocked materials can be ordered and reasonable preparations made for equipment rehabilitation.

(4) Copperweld wire be used wherever theft and sabotage has proved a hazard to landline operation, and that alignments be moved, if necessary, to follow roads and/or railways for maximum protection and for ease of maintenance. Punitive or other deterrent actions to eliminate sabotage should be thoroughly explored.

(5) As the initial phase of the landline rehabilitation program, Telecommunications make an all-out effort to restring and maintain commercial lines on pole structures that are now carrying only railway control lines.

(6) Radiotelegraph stations retained as a security measure in communities served by landlines be supported from the defense budget.

(b) **Telephone.** This program is in two areas: automatization of the Rangoon exchanges, and expanding and improving the district exchanges. It is recommended that:

(1) The recently established organization for conducting the affairs of the Rangoon telephone service be given the latitude and assistance required to modernize the operation of Burma's largest telephone system.

(2) Modern Crossbar exchanges be installed at Main, North and Insein for full automatization of the service, and that a new outside plant including a conduit system in the downtown area be provided. It is further urged that provision be made for 6,000 lines in Main, 2,000 in North and 300 in Insein, to allow for reasonable expansion of telephone-use in Burma's capital city during the first five-year period.

(3) Telecommunications obtain the centrally located sites for, and design the buildings required by the automatization program. Optimum locations have been suggested in various reports.

(4) Serious thought be given to limiting the new manual installation (40th Street Telephone Building) to 2,000 lines if action on automatization is to follow in the very near future. The present South Exchange can be kept in operation for another two or three years to provide, with the new boards, 3,000 lines. This would result in substantial savings in batteries, installation time and cut-over problems. The third 1,000-line board can be shipped to Mandalay where it will soon be required.

(5) Telecommunications standardize, by specifications and drawings, the apparatus and materials needed in the operation of the telephone system. Enough laboratory facilities must be provided to permit essential electrical measurements. Sufficient equipment performance data should be recorded to serve as a basis for future purchasing.

(6) Modern practices in outside plant construction and maintenance, notably distribution point and drop wiring, be adopted.

(7) Large-scale city maps showing outside plant installations be accurately drawn, and kept up to date. Along with these should be accurate cable test data to permit trouble location with test instruments.

(8) Telecommunications establish well planned and capably conducted training classes for all grades of telephone technicians as one of the first steps in improving and standardizing operations. Also, that selected technicians be sent to the United States or Sweden for training.

(9) Plans be laid immediately for expanding the local telephone exchanges in the district communities of over 10,000 population by installing properly designed C-B telephone systems. This should include the preparation of complete instructions and forms so that the local subdivisional officers can conduct a subscriber-demand survey, and can furnish the necessary technical information for layout of the outside plant.

(10) The many detailed measures for providing Mandalay with a C-B telephone system can be undertaken at once so that when trunk lines to Rangoon are restored, the demands for telephone service can be handled. The present 400-line magneto exchange is entirely inadequate to meet the future needs of 182,000 people for modern telephone facilities. The equipment freed by Rangoon's automatization can be used to advantage in the districts.

(c) **Telephone system maintenance.** Maintenance is one of the major considerations in operating a telecommunications system. To improve and expand the Department's efforts along this line, it has been recommended that:

(1) Telephone maintenance standards be established and rigidly enforced.

DEPARTMENT OF TELECOMMUN

TELEPHONE

Division	Sub-Division	Station	Capacity of Switch-board	Subscriber's Connections in use	Working Hours	Staff								Local Telephone Lines (miles)	Telephone Trunk Lines	Leased Lines	
						Asst. Engineer	Eng. Supv.	Phone Insp.	Line Insp.	Sub. Insp.	Lineman	Operator	Exch. Supv.			Railway	Canal
NORTH BURMA	MANDALAY	Mandalay	400	305	0000–2400	2	3	1		2	6	12					
		Monywa	40	18	0600–2000		1			1	1	2					
		Sagaing	40	33	0600–2000						1	2					
		Kyaukse	40	23	0600–2000						1	2					
		Shwebo	80	23	0600–2000		1				1	2					
		Bhamo	40	12	0600–1800						1	2					
		Katha	20	14	0600–2000		1				1	2					
		Myitkyina	40	18	0600–1800						1	2					
		Kalewa	40	12	0600–1800		1				1	2					
		Meiktila	100	57	0000–2400		1			1	2	4					
		Putao															
		Homalin															
		Mawlaik															
		Paunglyin															
		Shwegu															
		Mogok															
		Amarapura															
		Myinmu															
		Myitgne															
			840	515		2	8	1		4	16	32		668·2	556	766	60
	TOUNGOO	Toungoo	50	35	0000–2400	1	1			1	2	5					
		Aungban	20	7	0600–1800						1	2					
		Yamethin	20	15	0000–2400						1	4					
		Pyinmana	10	4	0600–1800						1	2					
		Nyaunglebin	20	12	0600–1800						1	2					
		Pyawbwe	20	6	0600–1800						1	2					
		Thazi	20	4	0600–1800						1	2					
		Taunggyi	50	54	0000–2400					1	1	4					
		Kalaw	40	18	0000–2400						1	4					
		Pyu	20	5	0600–1800						1	2					
			270	160		1	1			2	11	29		275	650	1390	70
	YENANGYAUNG	Yenangyaung	100	52	0000–2400	1	1				2	4					
		Myingyan	80	59	0000–2400		1				2	4					
		Minbu	50	19	0600–1800						1	2					
		Magwe	50	6	0600–1800						1	2					
		Chauk	10	8	0600–1800						1	2					
		Pakokku	50	13	0600–1800						1	2					
		Nyaungoo	25	4	0600–1800						1	2					
		Gangaw															
		Kanpetlet															
		Taungdwingyi															
		Minhla															
			365	161		1	2				9	18		391	36	57	26
	MAYMYO	Maymyo	120	72	0000–2400	1	1	1		3	2	7					
		Namtu															
		Lashio	50	44	0600–2000						2	2					
		Hsipaw	44	37	0600–2000						2	2					
		Kyaukme	50	28	0600–2000						2	1					
		Nyaungkhio															
			264	181		1	1	1		3	8	12		140	1025	491	

CATIONS—PRESENT FACILITIES

		TELEGRAPH																				RADIO										
		Staff																					*Frequency*		*Staff*							
Schedule Hours	Average Traffic Total	*Supt.*	*Asst. Supt.*	*Teleg. Master*	*Telegraphist*	*S. G. Clerk*	*1. G. Clerk*	*2. G. Clerk*	*L. R. Clerk*	*Peon Insp.*	*San. Insp.*	*Cycle Mech.*	*Time-keeper*	*Duftry*	*Messenger*	*By Hand Peon*	*Office Peon*	*Boy Peon*	*Durwan*	*Sweeper*	*Water-man*	Call Sign	*Transmit*	*Receive*	*Asst. Eng.*	*Supervisor*	*Operator*	*Eng. Driver*	*Oiler*	*Durwan*	*Peon*	*Sweeper*
0700-2200	33670	1		2	32		4	4		1					11	1	2	6		1		XYQ 8				1	29	6		2		2
1000-1700	1570																					XYK 3				1	2	1			1	
0900-1700	910																															
1000-1700	365																					XYD 6	3360			1	2	1			1	
1000-1700	565																					XYN	3360				3	1			1	
0900-1700	1180														1																	
0900-1700	1500																															
															1							XYL 3	6380	6370			3	1		1		
1000-1600	2900																					XYC	5820	3380		1	2	1				
0900-1700	1000																					XYD 4	5180			1	2	1			1	
0900-1700	525																					XYL 9	6380			1	1	1		1	1	1
0800-1700	500														1							XYC 4	3380				2	1		1	1	
0800-1700	1100														1							XYC 2	3380				2	1		1	1	
0800-1700	820														1							XYC 3	3380				2	1		1	1	
0900-1700	95																					XYZ 2	3710				2	1			1	
0800-1600	740														1							XYL 5	5740				2	1		1	1	
1000-1600	95																															
1000-1700	20																															
0900-1700	-																					XYV 7	3720	4165			3	1			1	
	47555	1		2	32		4	4		1					17	1	2	6		1						6	57	19		8	11	3
0900-1900	1550																															
0800-1700	260																															
0900-1700	615																					XYD 2	5180			1	2	1			1	
0900-1700	225																															
1000-1700	205																															
0900-1700	1500																					XYD 5	3360			1	2	1			1	
1000-1700	235																															
	4590																									2	4	2			2	
0900-1700	1470				1										1							XYD 3	5180			1	1	1			1	
0900-1700	1710				1										1							XYC 9	5740			1	2	1			1	
0900-1700	405																					XYK 2	3720			1	2	1			1	
0900-1700	655																					XYD 7	3360			1	2	1			1	
0900-1700	1665				2																	XYL 8	5820			1	3	1		1		
1000-1700	1940																					XYC 5	3700			1	2	1			1	
0900-1700																						XYV 6	5180	5635			3	1			1	
0900-1700	155														1							XYL 6	5820				2	1		1	1	
1000-1700	270																					XYC 6	3600			1	1	1		1	1	
0900-1700	410														1							XYL 7	5740			1	2	1		1	1	
0900-1700	26																					XYT 9	5170	5625			3	1			1	
	7706				4										4											8	23	11		4	10	
1000-1600	1310																															
0900-1600	260																															
0900-1700	975																					XYD 8	3360				3	1			1	
0900-1700	220																															
0900-1700	300																															
0900-1600	45																															
	3120																										3	1			1	

TELEPHONE

Division	Sub-Division	Station	Capacity of Switch-board	Subscriber's Connections in use	Working Hours	Staff								Local Telephone Lines (miles)	Telephone Trunk Lines	Leased Lines	
						Asst. Engineer	Eng. Supv.	Phone Insp.	Line Insp.	Sub. Insp.	Lineman	Operator	Exch. Supv.			Railway	Canal
SOUTH BURMA	RANGOON	Taikkyi	25	2													
		Tharrawaddy	25	20													
		Pegu	100	70													
		Twante	20	7													
		Syriam	25	11													
		Rangoon CTO				1	3		1								
		University Telegraph office															
		Ahlone Telegraph office															
			195	110		1	3		1					220·0	935·0	1312	32
	MOULMEIN	Moulmein	180	179	0000–2400	1	2										
		Tavoy	100	81	0000–2400												
		Mergui	50	33	0000–2400												
		Thaton	30	23	0000–2400												
		Kanbauk															
			360	316		1	2							269·4	343·36	290·19	
	PROME	Prome	60	49	0000–2400	1	2										
		Thayetmyo	25	18	0000–2400												
		Allanmyo	10	5	0000–2400												
		Paungde	20	11	0000–2400												
		Shwedaung															
		Thegon															
		Zigon															
			115	83		1	2							426·8	252·5	397·7	
	BASSEIN	Bassein	180	99	0000–2400	1											
		Myaungmya	35	21	0600–1800												
		Wakema	25	7	0800–2000												
		Moulmeingyun	10	2	0900–1700												
		Bogale	5	3	0900–1700												
		Pyapon	20	18	0000–2400												
		Kyaiklat	20	11	0900–1700												
		Maubin	25	21	0600–1800												
		Yandoon	10	8	0900–1700												
		Henzada	50	36	0000–2400												
		Zalun	10	7	0900–1700												
		Myanaung	10	3	0900–1700												
		Yegyi	20	7	0600–1800												
		Kyonpyaw	10	4	0900–1700												
		Ngathaingyaung	10	2	0900–1700												
		Kyaunggon	10	3	0900–1700												
		Danubyu															
		Kyangin															
		Einme															
		Pantanaw															
			450	252		1								202·6	470·5	95·8	

CATIONS—PRESENT FACILITIES

		TELEGRAPH																				RADIO										
		Staff																					Frequency		Staff							
Schedule Hours	Average Traffic Total	Supt.	Asst. Supt.	Teleg. Master	Telegraphist	S. G. Clerk	1. G. Clerk	2. G. Clerk	L. R. Clerk	Peon Insp.	San. Insp.	Cycle Mech.	Time-keeper	Duftry	Messenger	By Hand Peon	Office Peon	Boy Peon	Durwan	Sweeper	Water-man	Call Sign	Transmit	Receive	Asst. Eng.	Supervisor	Operator	Eng. Driver	Oiler	Durwan	Peon	Sweeper
0900-1700	550																					XYF 6	5300			1	1	1			1	1
0900-1700	130																															
1000-1700	140																															
0000-2400	65080	1	3	5	83	6	34	35	13	1	1	2	2	1	61	9	8	33	6	11	1											
0930-1630	15																															
0800-1630	20																															
	65935	1	3	5	83	6	34	35	13	1	1	2	2	1	61	9	8	33	6	11	1					1	1	1			1	1
0900-1900					3		2								3	1	1					XYG	7800			1	8	1	1	1	1	1
																						XY 7										
					2										2			1		1		XYT 2	5925	5810			3			1		1
					2										2			1				XYG 2	5925			1	2	1		1	1	1
																						XYG 3	5925			1	1	1			1	1
					7		2								7	1	1	2		1						3	14	3	1	3	3	4
0800-1800	2100				2										2		1			1		XYF	3760			1	2	1		1	1	
0900-1600	390																					XYF 5	5180			1	2	1			1	1
0900-1700	4																															
0900-1700	120																															
0900-1700	100																															
	2714				2										2		1			1						2	4	2		1	2	1
0900-1900	1110																					XYX 1 XYX 2	5750	8100		1	4	2		1	1	1
0800-1400	430																					XYG 4	5300			1	1	1			1	
0900-1700	14																					XYK 6	5120	5575			3	1			1	
0930-1800	345																					XYG 5	5300			1	1	1			1	1
0900-1700	60																															
0900-1700	770																					XYF 7	3750			1	1	1		1	1	
0900-1700	100																															
0700-1800	2800																					XYF 4	5300				3	1			1	
	10																					XYK 8	5120	5575			3	1			1	
	8																					XYJ 9	5140	5595			3	1			1	
	8																					XYK 4	5300	5755			3	1			1	
	8																					XYK 7	5140	5595			3	1			1	
	5663																									4	25	11		2	10	2

TELEPHONE

Division	*Sub-Division*	*Station*	*Capacity of Switch-board*	*Subscriber's Connections in use*	*Working Hours*	*Staff*								*Local Telephone Lines (miles)*	*Telephone Trunk Lines*	*Leased Lines*	
						Asst. Engineer	*Eng. Supv.*	*Phone Insp.*	*Line Insp.*	*Sub. Insp.*	*Lineman*	*Operator*	*Exch. Supv.*			*Railway*	*Canal*
ARAKAN	AKYAB INDEPENDENT	Akyab	200	171	0000–2400	1	2	1		3	25	6					
		Kyaukpyu	40	20	0500–2300					1	2	3					
		Sandoway	20	9	0500–2300						2	3					
		Maungdaw	(Non-Ex.)	3	0000–2400						1						
		Cheduba															
		Kyauktaw															
		Minbya															
		Paletwa															
		Singaling Khamti															
			260	203		1	2	1		4	30	12					
PROME	RANGOON AREA	Rangoon North Exchange	540	525	0000–2400		1	1		1	3	22	1				
		Mingaladon	150	132	0000–2400		1	1			3	12	1				
		Insein	100	62	0000–2400		1				1	5	1				
		Central	400	360	0000–2400		1					17	1				
		Regent	440	440	0000–2400							4	1				
		West	340	340	0000–2400							4	1				
		South	1099	1093	0000–2400	1	1	1			15	53	8				
			3069	2952		1	5	3		1	22	117	14	10·762			
		Rangoon Radio															
		Rangoon Transmitting Station															
		Rangoon Recrad and High-speed Station															
		Rangoon–Moulmein R/T															
		Maymyo Alexander Barracks															
		Daik-U															
		Kawlin															
		Myitgne															
		Pyuntaza															
		Sagu															
		Salin															
		Singu															
		Tatkon															
		Taungtha															
		Thedaw															
		Yawnghwe															
		Zeyawaddy															

CATIONS—PRESENT FACILITIES

TELEGRAPH																						RADIO										
		Staff																					Frequency		Staff							
Schedule Hours	Average Traffic Total	Supt.	Asst. Supt.	Teleg. Master	Telegraphist	S. G. Clerk	1. G. Clerk	2. G. Clerk	L. R. Clerk	Peon Insp.	San. Insp.	Cycle Mech.	Time-keeper	Duftry	Messenger	By Hand Peon	Office Peon	Boy Peon	Durwan	Sweeper	Water-man	Call Sign	Trans-mit	Receive	Asst. Eng.	Supervisor	Operator	Eng. Driver	Oiler	Durwan	Peon	Sweeper
0900-1800	5217			1	10		1	4							5	1	1	1	1			XYA 8	7660	7760		2	17	6		1	8	1
0900-1630	500															1						XYA 3	6790				2	1		1	1	
0900-1630	600															1						XYA 3	6790				3	1		1		
1000-1700	120															1						XYA 4	5810				2	1		1		
1000-1700	60															1						XYB 3	4270				3	1		1		
1000-1700	60															1						XYA 2	4270				2	1		1		
1000-1700	50															1						XYB 3	4270				2	1				1
1000-1200																1						XYS 4	5810	6265			2	1			1	
0900-1700	475															1						XYC 8	3380			1	1	1			1	1
	7082			1	10		1	4							5	9	1	1	1							3	34	14		6	11	3
																						XYR 2	250		1	1	34	6	2	1	1	3
																						XYR 3	500									
																						XYR 4	4200									
																						XYR 5	12600									
																						XYR 6										
																						XYR	16800									
																						XYM	13020	7675								
																						XYM 2										
																						XYM 3	12385	7690	1	4	12	7	1	1	1	3
																						XYM 4										
																						XYM 5	7645	5925								
																						XYM 6										
																						XYM 7	12870									
																						XYM 8										
																						XYM 9	13655									
																						XYN										
																						XYNO	13395	5300								
																						XYN 3										
																						XYN 4	17580	7600	1	4	29	6	1		1	1
																						XYN 5										
																						XYN 6	15470	7600								
																						XYN 7										
																						XYN 8	12387	6900								
																						XYN 9	7680									
																							7400	7200								
																							7500	7300	1	2	1	1				
1000-1700	75																															
0900-1700	45																															
0900-1700	15																															
1000-1700	40																															
0900-1700	45																															
1000-1700	25																															
1000-1700	200																															
1000-1700	20																															
1000-1700	9																															
1000-1700																																
1000-1700																																
1000-1600	2																															
0930-1630	105																															
	579																															

(2) Material necessary for proper maintenance be carried at all times by Telecommunications stores. This must be given a first priority by all concerned.

(3) Maintenance men be provided with the necessary tools and transport for meeting their responsibilities quickly and competently.

(4) A complete system of tests and records be set up and rigidly maintained to assist outside plant maintenance personnel in locating cable faults. The present trial and error procedures are untenable in this age of precise electrical measurements.

(5) Daily trouble records be meticulously kept so that average "out time" can be calculated, and the major fault reasons be catalogued.

(6) Functional telephone-plant bodies be obtained for the Ford truck chassis at the Telecommunications stores.

(7) The acceptance of gratuities by maintenance personnel for "preferred" services be thoroughly suppressed and replaced by cultivated pride in organization.

(d) Central Telegraph Office. A study of this most essential component of both foreign and domestic communications facilities has resulted in the following recommendations:

(1) The materials listed in section E–1–(*c*)–(6) should be provided at once to modernize and improve the telegraphic services.

(2) The message delivery and booking systems should be reviewed with the object of eliminating time-wasting procedures. Cash registers which furnish a printed receipt will eliminate "stamps," and a few motor cycles for long-distance deliveries will help materially.

(3) Telecommunications should insist that its messengers are uniformly attired.

(4) There should be a better appreciation and understanding of the traffic section's problems and contributions. All personnel carrying supervisory responsibilities should be given official status.

(5) Telephone or teleprinter should be used for forwarding messages between branch telegraph offices and the CTO to save skilled operators.

(6) Message delivery envelopes should be addressed with Addressograph equipment (coded addresses) and by typewriter (formal addresses) to eliminate errors.

(e) Marine Radio Station. It is recommended that the plan for moving the station be postponed until the whole matter is reviewed. If it is finally decided that the staff cannot be made a naval reserve unit and the station's location is incompatible with the Navy's effectiveness, the actual moving could be deferred until a more appropriate time when Telecommunications has less construction rehabilitation commitments.

(f) Organization. Of the many needed corrective actions in the field of organization, the most pressing are these:

(1) An engineering group be established within the radio section as a part-time committee to plan the pressing expansion activities on a more appropriate scale than at present. As soon as the technical manpower situation permits, this group should become part of a full-time engineering section within the Department.

(2) An engineering group be established to work out the practical rehabilitation of Burma's landline system and the related details of expanded telephone-telegraph working. The economical and satisfactory service to be engineered from the huge investment in the lines system deserves greater attention.

(3) All telecommunications engineering recommended in the body of this Report be ultimately concentrated into a single component engineering-planning section to serve the whole Department.

(4) A radio regulatory body, with duties and responsibilities as outlined in paragraph E–3–i–(6), be established outside the Department of Telecommunications but under the parent ministry.

(5) To minimize departmental reorganization and yet provide essential services, personal assistants to the Director be added in the areas of personnel, training and accounting-finance.

(g) Personnel. It is recommended that:

(1) Departmental regulations covering administrative procedure be thoroughly enforced. Where these regulations are found to be weak or unsuitable appropriate changes should be made.

(2) Higher standards of job quality be imposed and enforced.

(3) The entire salary scale be reviewed in the light of the findings of the Wider Pay Commission. This would go far toward winning the much needed loyalty to the program.

(4) The procedures provided in the regulations for the removal of the incompetent and inefficient be exercised. The harboring, protection, or coddling of such individuals has an extremely depressing effect on the morale and efficiency of the service.

(5) The necessity for and the importance of training and personnel administrative programs be recognized by detailing responsible officers to these functions (see Organization, Section E–3).

(6) A procedure be established for objective evaluation of demonstrated qualifications for promotion in addition to the facts of seniority. Technical qualifications should be established by both written and performance examinations.

(7) More attention be focused upon improved morale by appropriate recognition of superior performance.

(h) Training. To meet the training needs of all echelons of the organization, it is recommended that:

(1) A training program be carefully developed considering both vocational and professional aspects, both on-the-job and full-time opportunities, both extension and residence instruction, and possibly day and evening classes.

(2) This training program utilize the best available techniques of instruction, embracing both long-range and accelerated objectives.

(3) The compilation of a good technical library be instituted at once under the supervision of a competent librarian.

(4) That funds appropriated for this training program be adequate for the provision of training aids, shops or practical laboratories, classrooms and equipment. A modest honorarium should be offered staff members for teaching their specialities.

(5) A rigorous experience-training program be required for all engineering recruits, and that permanent employment depend largely on ability demonstrated therein.

(i) Financial matters. It is recommended that:

(1) An annual report similar to that used before the war be published within three months after the close of each fiscal year.

(2) Mechanized accounting be adopted to improve the speed and accuracy of the accounting function.

(3) A personal assistant, finance, be added to the Director's staff.

(4) The above officer, selected for ability and thorough experience in Burma Telecommunications accounts, be sent to London to study the modern accounting methods of the British Post Office in respect to telecommunications.

(j) Charts, maps and records. It is recommended that:

(1) A modern print-reproducing machine be obtained for Telecommunications headquarters to provide efficient printing service for all sections of the Department.

(2) Adequate drafting tables as well as map and chart storage facilities be provided. Drawings should be prepared so that these items of furniture can be constructed locally.

(3) All divisions and subdivisions be responsible for preparing certain minimum graphic information illustrating plans and the progress of operations.

(4) Drawer-type filing cabinets be provided as standard equipment in all offices of the Department.

(5) An improved and more complete method of indexing file contents be employed.

(6) The study of charts, maps and records be continued on an appropriate scale with attention to new and functional forms where required.

(k) Rates and charges. It is recommended that:

(1) The traffic department designate a competent person to study and handle all matters in connection with rates and charges. He must be familiar with all phases of traffic and cost accounting so that he can establish a schedule which will produce the necessary income, yet compare favorably with universal practice.

(2) The traffic department gather pertinent information on zoning and rate-setting for reference in preparing a schedule for Government approval. The philosophy of charging what the traffic will bear for telephones is as untenable as charging too little for telegraphic service.

(3) Monthly telephone billing be established with adequate forms and office machines for rapidly and accurately conducting this phase of the business.

(4) Special services at appropriate rates be introduced as soon as trunk working is resumed.

(l) Stores organization. Because of the importance of the stores in the operation of the Department, it is recommended that:

(1) The financial authority of the Director be increased to reduce the number of sanction requests necessary unless a much less cumbersome procedure is installed.

(2) The post of Superintendent of Stores because of its responsibility be improved in rank to equal that of Divisional Engineer.

(3) Business machines be adopted for improving the records and saving time and manpower.

(4) An emergency project head be set up during this period of expansion and rehabilitation to facilitate withdrawing specific instruments and tools.

(5) The Superintendent of Stores be granted modest financial authority, subject to regular audit, for emergency purchases on the local market.

(m) Requirements for further study. In addition to the matters discussed in this Report, several specific subjects require further study and exploration, and the general problem of keeping abreast with current developments in the science of telecommunications requires constant attention.

(1) *Public Relations*

A vital requirement for public service is the constant cultivation of a behavior toward the public that reflects full realization that the service exists solely for the purpose of accommodating the public, both individually and collectively. The Telecommunications Department could improve its services immensely by two courses of action. The first would be to undertake a campaign of education among all employees to develop a spirit of courtesy, accommodation, and desire to find a better way of serving the customer. The second would be to establish a public relations or public information section charged with demonstrating and publicizing telecommunications services to the public. Both service-wise and revenue-wise, the success of a department can be greatly enhanced by well-directed advertising and solicitation.

(2) *Service to Government Departments*

The telecommunications needs of the Burma Railways, the Irrigation Department, the Inland Waterways, the Merchant Marine and other agencies must be adequately met if these agencies are to operate at maximum effectiveness. Their needs for independent communications systems will be reduced to a few specialized requirements when the Telecommunications Department demonstrates that it can provide dependable service throughout Burma at reasonable rates. The Telecommunications Department should study the needs of the other departments, should help them to devise systems and equipment that would better serve their needs, and should make available to them such services as it may be able to provide in installing and operating such equipment. The Department should seek to avoid the overcrowding of the high-frequency spectrum, and should do its best to support and to contribute to the orderly allocation of frequencies by international agreement.

(3) *Job Evaluation*

Telecommunications is using job titles, concepts and relative salary scales developed many years ago and no longer applicable to the duties being performed. Some of the more desirable and obvious changes have been previously pointed out. Considerable additional study is needed to eliminate many remaining inequalities resulting from modernization and changing operations. A systematic and scientific evaluation of each job should be undertaken as a primary responsibility of the personnel section of the administrative staff.

(4) *Administration*

A close study of the administrative structure of the whole Telecommunications organization would be profitable. Planned changes should be part of an over-all improvement scheme. A particular need is to devise a means of providing closer support for personnel in the field. This may mean strengthening and simplifying supervisory channels and emphasizing the responsibilities of the supervisors concerned for both the personal and professional welfare of the field employees.

(5) *Responsibility*

As with all functions of organization, both administrative and organizational, the responsibility for progress and improvement rests squarely with supervision. It is not enough that Telecommunications seek merely to provide adequate service; only in striving to become superior can an organization become adequate. It is a key virtue of supervision that it be able to stimulate throughout its organization a constant search and effort to improve while at the same time being able to temper change by recognition and continuance of equipment and methods of demonstrated value.

PART VI

POWER

CHAPTER XIX

ELECTRIC POWER

A. EARLY HYDROELECTRIC INVESTIGATIONS

During the years 1920 to 1923 inclusive, field investigations were made of numerous hydroelectric power sites throughout Burma by B. Raikes, Electrical Inspector to the Government of Burma and Officer-in-Charge, Hydroelectric Survey of Burma. The results were incorporated in a report dated 1924 entitled "Report on the work of the Hydroelectric Survey of Burma." All power sites which were investigated and found useful or believed to be useful by the survey are listed in Table XIX–1 together with brief extracts from the 1924 report. For most of the sites the continuous horsepower is given based on minimum stream flow without benefit of possible storage.

1. MOST USEFUL SITES

Generally the power sites listed in the Raikes Report are in remote areas inaccessible for construction and far from the population centers. Exceptions are as follows:

Power Site	*Possible Market*
Saingdin Falls	Akyab District
Pyaungsha Rapids, Namtu River	Mandalay Area
Namsan Falls	Northern Shan States
Balu Chaung at Loikaw	Southern Shan States
Bawgata Chaung	Rangoon Area
Pegu River	" "
Lampha Chaung	Amherst District
Hpaungdaw Chaung	Tavoy District

It is believed that the sites given above are the most useful based on the current status of transportation facilities and probable power demand in the near future. Each is discussed in detail later in this Report. Also a number of additional hydroelectric and steam developments are proposed which were not covered in the Raikes report.

TABLE XIX – 1

HYDRO POWER SITES INVESTIGATED AND FOUND USEFUL OR BELIEVED TO BE USEFUL BY THE HYDROELECTRIC SURVEY OF BURMA, 1924

Item No.	*Name*	*River*	*Locality*	*Available Power**	*Market*	*Remarks*
	Sheet No. 92†					
1	Chipwi Chaung	N'Maikha	Kachin State	—	—	
4	Indawgyi Lake	Mogaung	"	—	—	Lake area 40 sq. mi.
5	Hpalin Site	Irrawaddy	"	—	Bhamo and Myitkyina	Very large project.
6	Above Myitkyina	"	"	—	Myitkyina	"
7	Ledan Chaung	Ledan	Katha District	—	Katha	Good fall and storage.
8	Mole Chaung	Mole	Bhamo District	—	Bhamo	
9	Nampak Hka‡	Taiping	"	—	"	880 ft. natural head.
10	Namtabet Chaung‡	Namtabet	Kachin State	—	Myitkyina	150 ft. natural head.
11	Namli Hka	N'Maikha	"	—	"	
13	Tabak Hka	Namtabet	"	—	"	
14	Mile 31 from Bhamo‡	Taiping	Bhamo District	—	Bhamo	2,700 sq. mi. D.A.

* Continuous horsepower.
† Sheet No. and Item No. refer to drawings in the 1924 report.
‡ Investigated and found to be useful.

TABLE XIX – 1 (*continued*)

Item No.	*Name*	*River*	*Locality*	*Available Power**	*Market*	*Remarks*
	Alternative No. 1			10,000	Bhamo	35 ft. fall and 20 ft. dam plus 500 ft. tunnel and penstock.
	Alternative No. 2			14,000	„	57 ft. fall plus 1,840 ft. tunnel and penstock.
	Alternative No. 3			21,000	„	117 ft. gross head, high dam and long tunnel.
	Alternative No. 4			47,000	„	257 ft. gross head, higher dam, longer tunnel.
15	Umungya Hka‡	Taiping	Bhamo District	22,000	„	2,370 ft. fall and storage—canal and pipe line.
	Sheet No. 84†					
1	Cho Chaung	Yaw	Pakokku District	—	Kanpetlet	
3	Kyaukset Chaung	„	„	—	„	
7	Sidoktaya Site	Mon	Minbu District	—	Oil fields	400 cusecs min. flow.
15	Saingdin Falls‡	Saingdin	Akyab District	—	Akyab	
	Alternative No. 1			1,200	„	65 ft. fall 880 ft. canal, 470 ft. tunnel.
	Alternative No. 2			3,400	„	185 ft. hd., storage dam, 2,350 ft. pipe line.
17	Saw Chaung	Yaw	Pakokku District	—	Kanpetlet	Good flow and dam site.
21	Yaw River	Yaw	„	—	Pauk	„
	Sheet No. 93†					
3	Bernardmyo	Shweli	North Shan	2,700	Mogok	120 sq. mi. D.A. 3,000 ft. fall—10 cusecs.
5	Heho Falls‡	Heho	South Shan	4,000	Taunggyi	57 cusecs—777 ft. head using long canal and tunnel.
11	Khin Chaung‡	Nameik	North Shan	1,000	Mogok	20 cusecs—580 head using 2 mi. canal.
14	Nampai Chaung‡	Madaya	Mandalay District	—	Mandalay	
	No. 1 North of Kungpaw Village	„		1,800		100 ft. head with 4,000 ft. tunnel. 200 cusecs.
	No. 2 below Lapet Chaung	„		1,800		100 ft. head with dam. 200 cusecs.

* Continuous horsepower.

† Sheet No. and Item No. refer to drawings in the 1924 report.

‡ Investigated and found to be useful.

TABLE XIX – 1 (*continued*)

Item No.	*Name*	*River*	*Locality*	*Available Power**	*Market*	*Remarks*
15	Makchinu Chaung‡	Nam Pang	South Shan	400	Taunggyi	16 cusecs 250 ft.
16	Myinkyado Chaung‡	Panlaung	,, ,,	2,000	Kalaw	15 cusecs 1,500 ft.
17	Namsit	Nampawn	,, ,,	—	Lough Keng	"Reported useful."
21	Nam Chit‡	Shweli	North Shan	600	Bawdwin	10 cusecs 700 ft.
23	Nam Hpaung‡	,,	,, ,,	1,000	,,	15 cusecs 750 ft.
30	Nam Hka	Salween	South Shan	—	Kengtung	"Worth investigation."
32	Nankwe Lake‡	Paunglaung	Yamethin District	2,500	Yamethin	25 cusecs 1,110 ft.
33	Nam Lam‡	Shweli	North Shan	300	Bawdwin	Long canal and penstock.
40	Nam Mangkaha Ch.‡	,,	,, ,,	1,000	,,	,,
42	Nam Pan	Nam Teng	South Shan	—	—	400 cusecs min.
43	Nam Pang‡	Salween	,, ,,	—	Taunggyi	2,000 cusecs min.
	No. 1 Loi Ha Falls	(14 mi. from	mouth)			
	Alternative A			38,000		210 ft. head with 2,700 ft. pipe line.
	Alternative B			33,000		180 ft. head with 1,000 ft. canal and pipe.
	No. 2 Naung Wo Falls	(3 mi. above	Kengkham)	5,500		30 ft. head with 500 ft. canal and pipe.
	No. 3 Kunkha Village	(2 mi. below	Kengkham)	14,000		75 ft. head with 350 ft. canal and pipe.
45	Nam Paw‡	Shweli	North Shan	6,000	Namkhan —	600 cusecs with 100 ft. dam.
46	Nam Pawn	Salween	South Shan	—	—	580 sq. mi., 700 ft. fall in 35 mi.
47	Nam Po Song‡	Shweli	North Shan	450	Namkhan	20 cusecs 250 ft.
50	Nam Tawn	Nam Teng	South Shan	—	—	
51	Nam Teng‡	Salween	,, ,,	—	—	1,000 cusecs min.
	Alternative No. 1			36,000		396 ft. head, 1,000 ft. canal, 2,000 ft. pipe.
	Alternative No. 2			31,000		345 ft. head, 1,000 ft. canal, 800 ft. pipe.
52	Railroad Site‡	Namtu	North Shan	—	Hsipaw	3,000 cusecs min.
55	Namsan Falls	Nam Yao	,, ,,	—	Bawdwin	Probably capable further development W. storage.
56	Nam Yom	Nam Teng	South Shan	—	—	1,000 ft. in 10 mi. 200 cusecs min.
59	Panlaung‡	Panlaung	,, ,,	—	Meiktila	150 cusecs.
	No. 1 Singaung Lake			11,000		800 ft. head.
	No. 2 Telu Village			1,800		130 ft. head.
	No. 3 Minpalaung			16,500		180 cusecs, 234 sq. mi., 1,000 ft. head, 11,000 ft. canal.

* Continuous horsepower.

† Sheet No. and Item No. refer to drawings in the 1924 report.

‡ Investigated and found to be useful.

TABLE XIX – 1 (*continued*)

Item No.	*Name*	*River*	*Locality*	*Available Power**	*Market*	*Remarks*
	No. 4 Combined			27,000		150 cusecs 2,000 ft. head.
	No. 5 Ingon Village			2,000		Combined with flood control dam by PWD.
61	Pyaungshu Rapids‡	Namtu	North Shan	35,000	Mandalay	3,800 cusecs 100 ft. head 2,800 ft. tunnel.
63	Shweli River‡		North Shan	—	Mandalay	3,000 cusecs min.
	Alternative No. 1			280,000		1,039 ft. head, 5 mi. tunnel.
	No. 2			250,000		920 ft. head 4 mi. tunnel.
	No. 3			190,000		705 ft. head 3 mi. tunnel.
	No. 4			33,000		120 ft. head ½ mi. canal.
	No. 5			27,000		100 ft. head, dam and pipe line.
65	Zawgyi‡	Myitnge	South Shan	—	Taunggyi	300 cusecs
	Mong Hing Falls			11,000		400 ft. head canal and pipe line.
	Lawsawk			4,000		168 ft. head w. dam 7,300 ft. canal.
	Sheet No. 85†					
3	Naung Yo Chaung		Prome Dist.	—	Prome	
	Sheet No. 94†					
1	Balu Chaung	Nam Pawn	Loikaw	90,000	Taunggyi	2,000 ft. in 10 miles, 500 cusecs min.
2	Bawgata Chaung	Sittang	Pegu District	—	Pegu	
3	Bilin Chaung‡	—	Thaton District	—	,,	
4	Kawkareik Chaung		Amherst District	—	Moulmein	Rapid descent, Narrow gorges.
6	Lampha Chaung		,,	—	,,	2,000 ft. head.
8	Nam Tan Hpak	Nam Pawn	South Shan	—	—	1,000 ft. head.
9	Nawng Htao Lake	,, ,,	,, ,,	—	—	1,000 ft. head.
10	Pada Chaung‡	Sittang	Toungoo District	—	Toungoo	Too small for any but local needs.
13	Paunglaung‡	,,	Yamethin	—	Pyinmana	500 cusecs.
	No.1 Nancho Chaung			4,500		100 ft. dam.
	No. 2 Just upstream of Nancho Chaung			7,000		150 ft. dam.
15	Hatgyi Rapids	Salween	Thaton District	—	Moulmein	Very large power source.
16	Shwegyin Chaung‡	Sittang	Pegu District	—	Pegu	Part of the Yunzalin diversion.

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* Continuous horsepower.

† Sheet No. and Item No. refer to drawings in the 1924 report.

‡ Investigated and found to be useful.

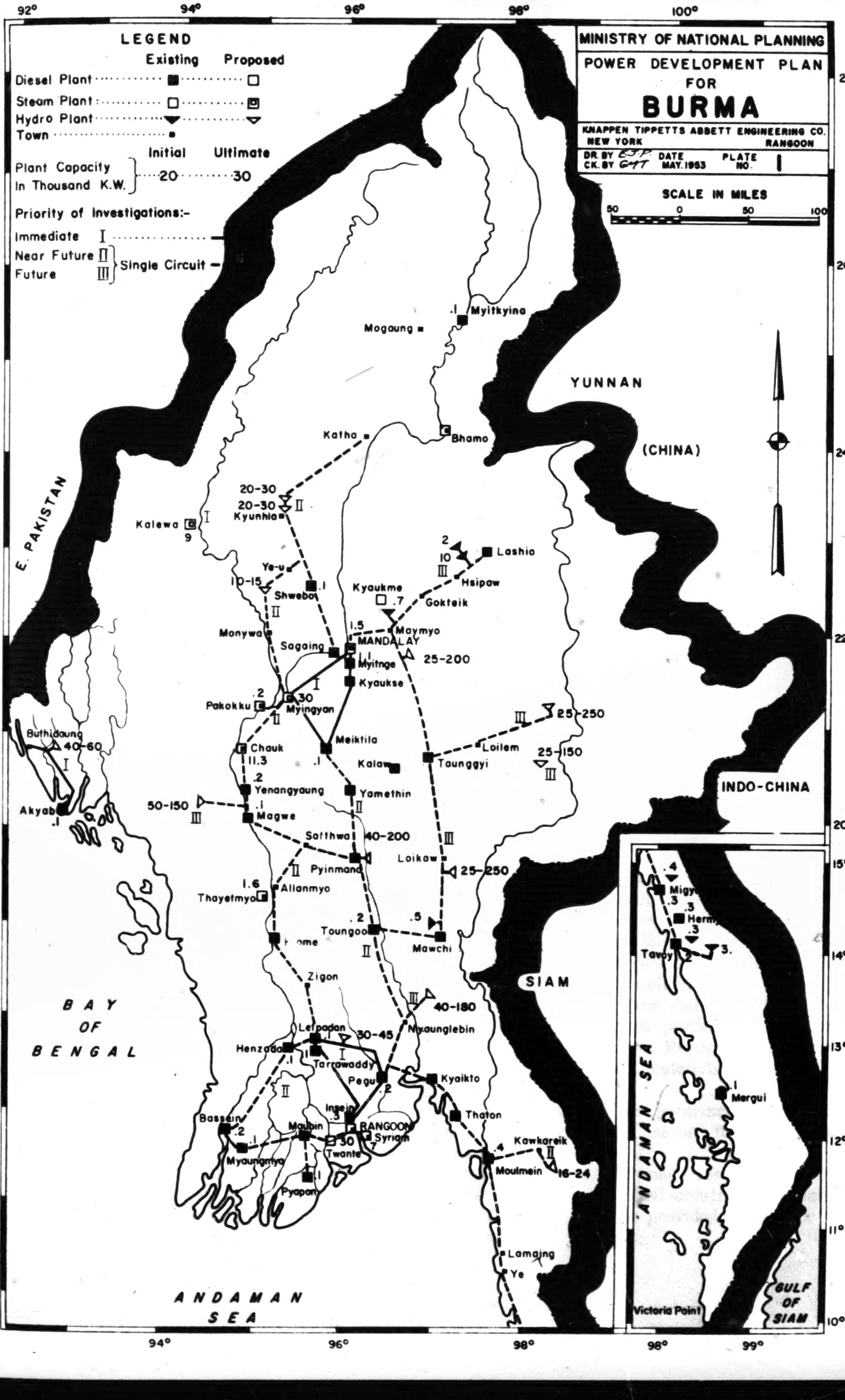

MINISTRY OF NATIONAL PLANNING
POWER DEVELOPMENT PLAN FOR
BURMA
KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK
RANGOON
DR. BY E.J.P.
CK. BY G.M.T.
DATE MAY. 1953
PLATE NO. 1
SCALE IN MILES
50
0
50
100
LEGEND
Existing
Proposed
Diesel Plant
Steam Plant
Hydro Plant
Town
Initial
Ultimate
Plant Capacity In Thousand K.W.
20
30
Priority of Investigations:-
Immediate I
Near Future II
Future III
Single Circuit
92°
94°
96°
98°
100°
28°
26°
24°
22°
20°
E. PAKISTAN
YUNNAN
(CHINA)
INDO-CHINA
SIAM
BAY OF BENGAL
ANDAMAN SEA
Myitkyina
Mogaung
Bhamo
Katha
Kyunhla
Kalewa
Ye-u
Shwebo
Kyaukme
Gokteik
Hsipaw
Lashio
Maymyo
Monywa
Sagaing
MANDALAY
Myitnge
Kyaukse
Pakokku
Myingyan
Meiktila
Chauk
Yenangyaung
Magwe
Kalaw
Taunggyi
Loilem
Yamethin
Satthwa
Pyinmana
Loikaw
Allanmyo
Thayetmyo
Toungoo
Mawchi
Prome
Zigon
Nyaunglebin
Letpadan
Henzada
Tarrawaddy
Pegu
Kyaikto
Thaton
Insein
Bassein
Maubin
RANGOON
Syriam
Twante
Myaungmya
Pyapon
Kawkareik
Moulmein
Lamaing
Ye
Buthidaung
Akyab
20-30
20-30
10-15
40-60
50-150
25-200
25-250
25-150
40-200
25-250
40-180
30-45
16-24
30
9
Migyi
Hermyingyi
Tavoy
Mergui
Victoria Point
ANDAMAN SEA
GULF OF SIAM
98°
99°
15°
14°
13°
12°
11°
10°

TABLE XIX – 1 (*continued*)

Item No.	*Name*	*River*	*Locality*	*Available Power**	*Market*	*Remarks*
19	Thauk-ye-gat‡	Sittang	Toungoo	5,000	Toungoo	550 cusecs. min. 150 ft. dam—good access.
20	Yunzalin‡	Salween	Salween District	—	Pegu	Special Report.
21	Zamagyi	Pegu	Pegu District	—	Rangoon	195 ft. falls in upper reaches.
	Sheet No. 95†					
1	Hpaungdaw Chaung‡	Tenasserim	Tavoy District	320	Tavoy	4 cusecs, 900 ft. head.
2	Kyaukpyu Chaung‡	Tavoy	„ „	330	„	3 cusecs—1,220 ft. head, long canal and pipe.
4	Tenasserim		„ „	—	„	Large storage possible.
	Sheet No. 96†					
	Lenya River		Mergui District	—	Mergui	Reported useful.

* Continuous horsepower.

† Sheet No. and Item No. refer to drawings in the 1924 report.

‡ Investigated and found to be useful.

B. PREWAR POWER SYSTEM

Much information on the prewar power system was destroyed during World War II. However, the annual report on the administration of the Electricity Act in Burma for the year ending December 31, 1939, details 102 public supply undertakings and 77 commercial and industrial undertakings for that year. Of the former all were small diesel plants, 10 to 500 kW, except for the 24,000 kW Rangoon Steam Station and nine minor hydro and steam stations. Of the industrial undertakings six were hydro stations ranging from 300 to 10,000 kW; 24 were diesel plants up to 1,300 kW; and the remainder were steam stations up to 20,000 kW capacity. About 48,000,000 kWh were generated for public supply in 1939 and 185,000,000 kWh for commercial and industrial use. A comparison of the prewar development with the existing power system (1952) is made in Table XIX-2 (*see next page*) entitled "Public Electric Supply, Prewar and Postwar," indicating that much work is yet required to restore the prewar facilities and production.

C. EXISTING POWER DEVELOPMENT

On Plate 1 are shown existing public and private power plants in sufficient detail to indicate concentrations of load and to plan a transmission network supplied by a few large generating stations. Table XIX-2 contains details of existing public supply installations wherever it has been possible to obtain the data. Questionnaires were sent out July 1952, with poor results. More recently 80 power plants throughout central Burma and the Delta were visited in order to complete the inventory. The results given in Tables XIX-2 and XIX-3 (*see p. 566*) include annual kWh generated in 1951 or 1952, and the estimated future demand, based on the statements of local people, businessmen and power plant operators. This represents local desires rather than long-range planning by trained personnel.

D. INITIAL DIESEL PLANTS AT 36 TOWNS

The Electricity Supply Board has prepared a plan for the installation of diesel and small hydro plants at 36 towns in accordance with Table XIX-4 (*see p. 572*). The work will include extensive transmission lines and municipal and rural distribution systems. The plan is scheduled for immediate construction to be completed in about three years. It will assist in early completion of various portions of the longer range plan presented in this Report without appreciable waste of labor and materials, subject to the following comments:

1. It is recommended that permanent transmission towers or poles suitable for use with the hydroelectric system be installed.
2. Provision should be made for double circuit lines on much of the initial construction, though single circuits only will be provided at first for the sake of early completion.

TABLE XIX – 2

PUBLIC ELECTRICITY SUPPLY—PREWAR AND POSTWAR

Division and Town	*1939*				*1952*					*Estimated Future Demand*	
	Population (thousands)	*Capacity (kW)*	*Type of plant*	*Thousand kWh generated annually*	*Population (thousands)*	*Capacity (kW)*	*Type of plant*	*Thousand kWh generated in 1951*	*Thousand kWh generated in 1952*	*Authorised new load (kW)*	*Possible additional load (kW)*
Arakan Division											
Akyab	38	138 50	D S	[2] 123	42	130	D	248	Inventory not completed		
Pegu Division											
Daik-U	5	45	D	50	10	(Destroyed)		—	—	—	1,210
Gyobingauk	8	78	D	79	10	78	D	105	132	—	1,250
Hlegu	5	29	D	31	7	(Destroyed)		—	—	—	625
Kanyutkwin	5	50	D	—	6	(,,)		—	—	—	370
Kayan	7	97	D	90	19						
Kyauktan	5	35	S	36	10	(Destroyed)		—	—	—	350
Letpadan	12	97	D	94	16	66	D	—	94	—	2,283
,, (Municipal)	12	30	D	40	—	—	—	—	—	—	—
Minhla	4	49	D	61	6	49	D	65	77	—	1,025
Nattalin	6	43	D	68	9	43	D	81	92	—	2,295
Nyaunglebin	8	90	D	112	16	90	D	62	68	—	1,030
Pyu	8	157	D	126	10	(Destroyed)		—	—	—	1,235
Pegu	22	192	D	270	46	258	D	286	307	—	1,410
Paungde	13	105	D	94	17	(Not Commenced)			—	130	1,263
Prome	28	288	D	648	37	130	D	132	252	—	1,340
Pyuntaza	6	17	D	9	10	(Destroyed)		—	—	—	725
Rangoon and Insein	421	24,000	S	34,151	688	28,000	S	37,368	46,481	Table	XIX – 5
Shwegyin	6	67	D	61	5	(Destroyed)		—	—	—	650
Shwedaung	8	95	D	133	9	95	D	166	*	—	335
Sitkwin	3	14	D	6	5	(Destroyed)		—	—	—	664
Tharrawaddy	7	91	D	82	8	130	D	100	110	—	539
Thingangyun	8	70	D	55	18	(From RET)		61	—	—	—
Thongwa	9	55	D	54	11						
Thonze	8	55	D	54	14	(From Tharrawaddy)		50	79	—	995
Toungoo	7	305	D	251	31	162	D	114	168	—	2,590
Zigon	6	65	D	86	9	65	D	103	122	—	985
Kyaiktaw	3	8	D	22	—	(Destroyed)		—	—	—	—
Okpo	3	17	D	43	4	17	D	54	71	—	1,380
Oktwin	4	30	D	31	4	(Destroyed)		—	—	—	492
Syriam (Municipal)	15	(from BOC)		86	15	(from BOC)		42			
Taikkyi	4	22	D	42	9	(Destroyed)		—	—	—	1,135
Twante	4	18	D	7	7	(,,)		—	—	—	150
Waw	—	12	D	8	7	(,,)		—	—	—	535
Yedashe	2	31	D	36	5	(,,)		—	—	—	300

* Out of commission

D Diesel Plant. S Steam Plant. H Hydroelectric Plant.

TABLE XIX - 2 (*continued*)

PUBLIC ELECTRICITY SUPPLY—PREWAR AND POSTWAR

Division and Town	1939				1952					*Estimated Future Demand*	
	Population (thousands)	*Capacity (kW.)*	*Type of plant*	*Thousand kWh. generated annually*	*Population (thousands)*	*Capacity (kW.)*	*Type of plant*	*Thousand kWh. generated in 1951*	*Thousand kWh. generated in 1952*	*Authorised new load (kW.)*	*Possible additional load (kW.)*
awaddy Div.											
Bassein	46	325	D	396	77	152	D	—	425	100	3,037
Bogale	8	120	D	190	23	125·5	D	—	190	—	1,200
Danubyu	6	79	D	119	10	136	D	193	153	—	683
Dedaye	7	30	D	66	9	30·5	D	—	66	—	375
Henzada	29	194	D	216	61	130	D	27	178	—	3,509
Kungyangon	4	26	D	47	5	(Destroyed)		—	—	—	300
Kyaiklat	11	28	D	72	16	58·5	D	—	88	—	825
„ (Municipal)	11	22	D	40	—	(Combined)		—	—	—	—
Kyaunggon	4	41	D	42	4	(Destroyed)		—	—	—	150
Kyonpyaw	6	63	D	72	12	(„)		—	—	—	225
Kyangin	8	45	D	9	6	45	D	14	15	—	560
Maubin	9	107	D	124	23	49	D	20	30	—	150
Moulmeingyun	8	60 50	D S	130[2]	17	50·5	S	—	130	—	975
Myanaung	9	145	D	119	11	(Destroyed)		—	—	—	620
Myaungmya	8	140	D	18	24	130	D	22	128	—	1,263
Pantanaw	5	—	—	—	5	(Destroyed)		—	—	—	150
Pyapon	12	185	D	200	19	66	D	—	165	52	1,200
Wakema	9	72	D	68	19	42	D	15	18	—	600
Yandoon	10	110	D	151	15	44	D	—	29	—	693
Einme	4	18	D	22	—	(Destroyed)		—	—	—	150
Kangyi	—	6	D	17	—	(„)		—	—	—	—
Kwingauk	2	22	D	16	—	(„)		—	—	—	150
Kyonmange	3	32	D	12	10	(„)		—	—	—	150
Labutta	3	46	D	64	5	(„)		—	—	—	250
Myingagon	4	18	D	29	—	(„)		—	—	—	150
Mezaligon	—	(Revoked)		—	—	(„)		—	—	—	—
Ngathainggyaung	5	27	D	29	8	(„)		—	—	—	225
Ngamyethna Pagoda (Henzada)	—	22	S	14	—	(from Henzada)		—	22	—	22
Yegyi	1	10	D	11	4	(Destroyed)		—	—	—	225
Tenasserim Div.											
Kyaikto	7	65	D	125	13			Inventory not completed			
Mergui	20	120	D	146	34						
Moulmein	66	500	D	54	99	370	D	468			
Tavoy	29	154	D	146	40						
Thaton	17	207	D	285	38						
Kawkareik	7	31	D	36							
Mudon	4	22	D	11	20						
Palaw	—	17	D	9	6	35	D	4			

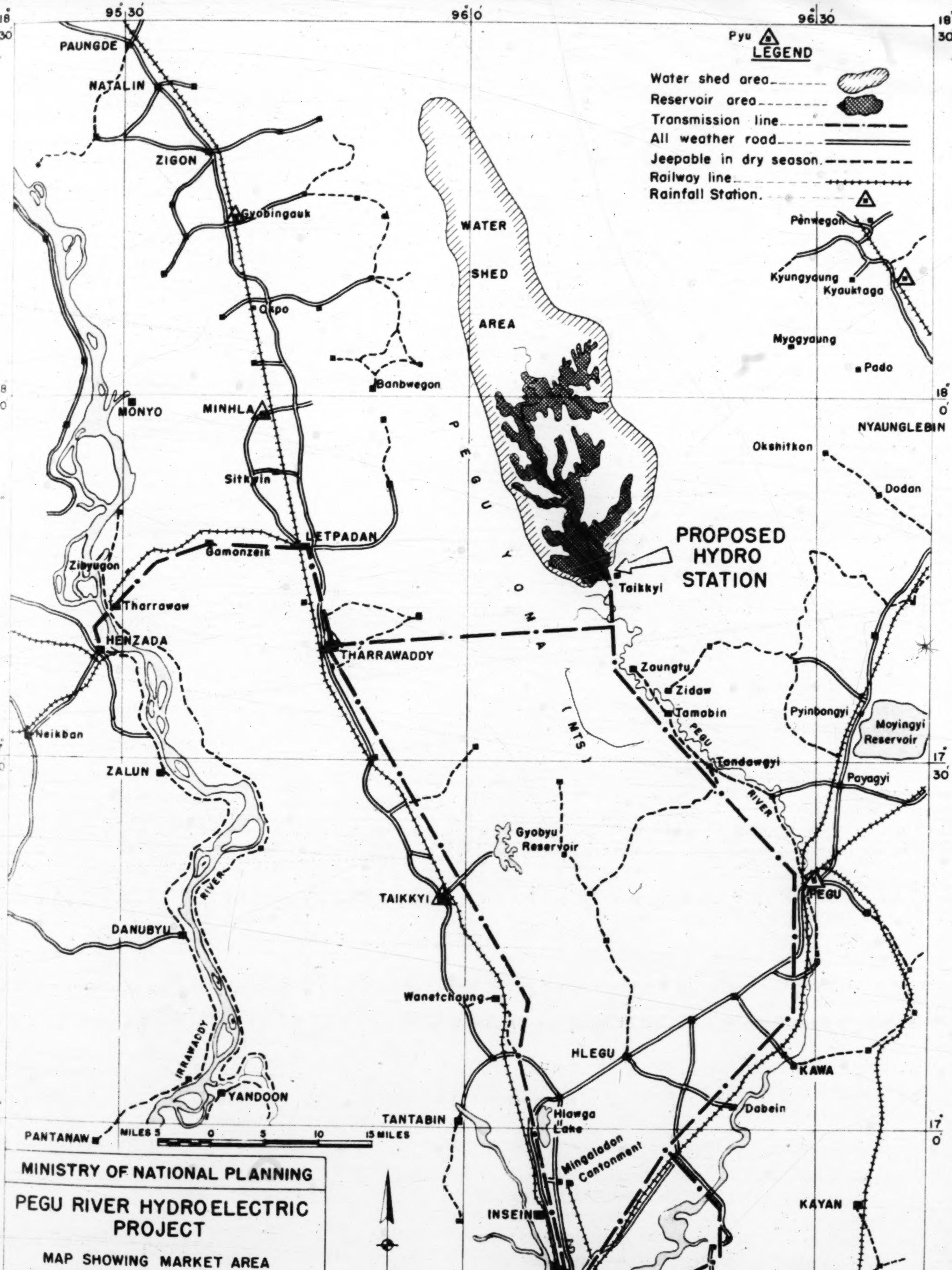
D Diesel Plant. **S Steam Plant.** **H Hydroelectric Plant.**

TABLE XIX – 2 (*continued*)

PUBLIC ELECTRICITY SUPPLY—PREWAR AND POSTWAR

Division and Town	*1939*				*1952*					*Estimated Future Demand*	
	Population (thousands)	*Capacity (kW.)*	*Type of plant*	*Thousand kWh. generated annually*	*Population (thousands)*	*Capacity (kW.)*	*Type of plant*	*Thousand kWh. generated in 1951*	*Thousand kWh. generated in 1952*	*Authorised new load (kW.)*	*Possible additional load (kW.)*
Magwe Division											
Allanmyo	13	22	D	61	16	(Destroyed)		—	—	—	2,270
Magwe	8	84	D	137	12	66	D	—	47	—	345
Yenangyaung	—	—	—	—	24	128	D	—	80	—	6,970
Pakokku	23	180	S	110	30	(Destroyed)		—	—	—	1,005
Thayetmyo	9	37	D	78	12	(,,)		—	—	50	815
Kama	3	18	D	30	4	18	D	—	27	—	303
Minbu	6	51	D	43	9	(Destroyed)		—	—	—	830
Salin	7	(Not Commenced)			—	—	—	—	—	—	880
Mandalay Division											
Amarapura	6	39	D	50	11	25	D	9	15	—	1,800
Mandalay	148	1,145 194	S D	2,396[2]	182	1,100 408	S D	464[2]	764	1,000	12,800
Maymyo	21	225 368	D H	602[2]	22	200 448	D H	887[2]	944	100	250
Myingyan	26	150	D	146	36	131	D	123	138	—	3,815
Meiktila	9	40	D	32	20	163	D	106	146	—	2,275
Nyaungoo	8	47	D	26	9	44	D	—	—	—	370
Pyawbwe	6	73	D	63	10	73	D	64	79	—	720
Pyinmana	18	208	D	284	22	(Not commenced)		—	—	44	1,650
Yamethin	9	44	D	79	11	56	D	36	44	—	1,070
Kyaukse	7	39	D	47	9	68	D	30	36	—	1,355
Lewe	—	—	(Revoked)		6	—	—	—	—	—	1,422
Sagaing Division								Inventory not completed			
Bhamo	80	62	D	79	10	76	D				
Katha	6	23	D	52	8	20	D				
Mogok	6	420	H	2,000	8	420	H	1,600	1,600	—	—
Monywa	11	93	D	127	26						
Myitkyina	7	95	D	114	12	76	D	22			
Sagaing	14	56	D	86	15	53	D	36	38	50	5,806
Shwebo	11	75	D	42	18	98	D	72	86	50	
Kawlin	3	25	D	36	4						435
Federated Shan States								Inventory not completed			
Hsipaw	5	63	D	69	—	76	D	—	—	—	—
Kyaukme	1	46	D	77	—	44	D	—	—	50	100
Lashio	5	60	D	43	—	66	D	30	48	30	30
Panghai E'Hang	—	33	D	56	—						
Taunggyi	9	65	D	84	—						
Namhsan	—	30	H	79	—						

D Diesel Plant. S Steam Plant. H Hydroelectric Plant.


95°30'
96°0'
96°30'
18° 30'
18° 0'
17° 30'
17° 0'
LEGEND
Water shed area
Reservoir area
Transmission line
All weather road
Jeepable in dry season
Railway line
Rainfall Station
Pyu
PAUNGDE
NATALIN
ZIGON
Gyobingauk
Okpo
Banbwegon
MONYO
MINHLA
Sitkwin
LETPADAN
Gamonzeik
Zibyugon
Tharrawaw
HENZADA
THARRAWADDY
Neikban
ZALUN
DANUBYU
IRRAWADDY RIVER
YANDOON
PANTANAW
MILES 5 0 5 10 15 MILES
WATER SHED AREA
PEGU YOMA (MTS)
PROPOSED HYDRO STATION
Taikkyi
Zaungtu
Zidaw
Tamabin
PEGU RIVER
Tandawgyi
Gyobyu Reservoir
TAIKKYI
Wanetchaung
HLEGU
Hlawga Lake
Mingaladon Cantonment
TANTABIN
INSEIN
RANGOON
SYRIAM
PYAPON
Dabein
KAWA
PEGU
Payagyi
Pyinbongyi
Moyingyi Reservoir
Okshitkon
Dodan
NYAUNGLEBIN
Penwegon
Kyungyaung
Kyauktaga
Myogyaung
Pado
KAYAN
THONGWA

MINISTRY OF NATIONAL PLANNING

PEGU RIVER HYDROELECTRIC PROJECT

MAP SHOWING MARKET AREA
AND TRANSMISSION LINE

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEWYORK RANGOON

DR. E.W. DATE . . . . PLATE
CK. GMT NO. . . . 2

3. Consideration should be given to steel towers, centrifugally cast concrete poles as made by the Hume Pipe Co., Singapore, and reinforced concrete poles of local manufacture. It is assumed that the Hume Company or similar firm would equip a manufacturing plant in Burma for the centrifugal poles in view of the large program being initiated.

4. Since the hydroelectric transmission system will be completed soon after the diesel system it is recommended that 132 kV be planned for primary transmission lines. For secondary lines 6.6 kV will be satisfactory except where excessive length may dictate a high voltage. Consideration is being given to 33 kV for a number of secondary lines now under study for the Myingyan–Mandalay system. It is likely that the same situation will exist in the Pegu–Rangoon system. The Electricity Supply Board will be consulted in this as detailed plans are developed.

5. Transmission line conductors should be adequate for the near future loads anticipated for the hydro system. Close liaison will be maintained with the Electricity Supply Board in this matter as well as in voltage requirements.

E. THREE LARGE POWER PLANTS FOR IMMEDIATE DEVELOPMENT

After detailed study of existing markets, population centers and probable industrial plants a selection of three moderately large power developments has been made. These are as follows:

Name of Project	*Initial Installation in Kilowatts*
Pegu River Hydroelectric Plant	30,000
Myingyan Steam Plant	30,000
Saingdin Falls Hydroelectric Plant	40,000

The listed projects can be completed within three to four years and will produce ample quantities of low cost power to supply the initial demand of a new industrial era. No unusual construction or transmission difficulties are anticipated in these developments.

1. PEGU HYDROELECTRIC PROJECT

a. General

The Government's objective is to supply a sizable block of low cost power to the Rangoon–Pegu–Henzada area. The power will be derived from the most economical source with due allowance for benefits to be obtained from interconnection of power plants and the supply of the smaller communities along the principal highways and railroads. For the Rangoon–Insein metropolitan area an accelerated growth is anticipated in part arising from the needs of the proposed steel mill and other heavy industry under consideration by the Government. At Henzada and Pegu planned dry weather irrigation pumping as well as ice factories, street lighting and pumping for domestic water supply will supplement the existing load. The Pegu River hydroelectric project is the most economical source of power in the area. It will be easily accessible after the insurgents have been cleared from nearby villages and after an all-weather road has been constructed to the site from the Pegu–Toungoo Highway. The project will also provide flood control and regulation, increasing the minimum flow from zero to 2,000 cusecs for irrigation, navigation and sanitation in the Pegu district.

b. Location

The site of the proposed power project (see Plate 2) is 40 miles upstream from Pegu on the Pegu River. It is just upstream from the village of Taikkyi. At this point the valley is narrow, though affording a substantial storage basin due to the existence of several lateral valleys above the dam site. The flooding of villages and rice lands will be avoided. There are no natural falls in this portion of the river, but about 160 feet of head can be developed by a dam without exceeding permissible abutment heights. Several earth dikes will be needed to seal off low saddles. No other dam site of equal value has been discovered along this section of the river, based on aerial photos, map study and reports from forestry officials and others familiar with the region. A reconnaissance and preliminary survey of the site were made on May 14–16, 1953.

c. Access

Forest trails and jeep roads provide access to the site during dry weather. The principal route follows the Pegu River from Payagyi via Aseiktaung and Zaungtu. An alternative route exists from Pyinbongyi along the foothills, where much gravel is available for road construction. This alternative is shorter and probably a better location except for the lack of military security. A study of both routes should be made by the Public Works Department in conjunction with military and forestry officials to determine the best route. Road construction should be started at once, in order to expedite the construction of the hydroelectric project. During the wet season access may be had by way of the river until an all-weather road is completed. River navigation to Zaungtu is not difficult except for the swift current during floods and the interference of bamboo rafts which move during the monsoon. Above Zaungtu navigation is hazardous because of the steeper river gradient. Access to Payagyi or Pyinbongyi from Rangoon may be had via asphalt paved highway or railroad.

TABLE XIX – 3 PUBLIC ELECTRIC SUPPLY–

City or Town	Rice Mills (1)	Oil Mills (2)	Saw Mills (3)	Wheat Mills (4)	Cotton Mills (5)	Dhall Mills (6)	Ice Factories (7)	Petroleum Refineries (8)	Sugar Refineries (9)	Weaving Factories (10)	Jail Industries (11)
Arakan Division											
Akyab											
Pegu Division											
Daik-U	600										
Gyobingauk	750		50								
Hlegu	150		75								
Kanyutkwin	225		75								
Kayan											
Kyauktan											
Letpadan	600	75	375				50				
„ (Municipal)											
Minhla	225	150	150								
Nattalin	1,125	300	300								
Nyaunglebin	375	75									
Pyu	525		150								
Pegu	375	75	150								
Paungde	150	150	75				38				
Prome	300	150	300				75				
Pyuntaza	225										
Rangoon and Insein			(Details are given in Table XIX–5, Pegu Hydroelectric Project)								
Shwegyin	75		75								
Shwedaung	75	35	75							50	
Sitkwin	300										
Tharrawaddy	150		75				50				50
Thingangyun											
Thongwa											
Thonze	525						50				
Toungoo	450	150	800				150				
Zigon	375		150								
Kyaiktaw											
Okpo	675		150				50				
Oktwin	75		75								
Syriam (Municipal)											
Taikkyi	225		200								
Twante	150										
Waw	225										
Yedashe	150		75								
Irrawaddy Division											
Bassein	1,050	150	300				100				55
Bogale	1,200										
Danubyu	225		35								
Dedaye	375										
Henzada	1,200	50	75				150			75	
Kungyangon	300										
Kyaiklat	825										
„ (Municipal)											
Kyaunggon	150										
Kyonpyaw	225										

(*a*) Tobacco Factories
(*b*) Leather Factories
(*c*) Kyazan Factories
(*d*) Bamboo Mat and Hat Factories
(*e*) Fruit Canning Factories

OSPECTIVE EXPANSION IN KILOWATTS

ttage ustries 12)	Salt and Fish Industries (13)	Pump Stations (14)	Workshops (Auto Repairs) (15)	Printing Presses (16)	Military (17)	Pagoda Lighting (18)	Town Lighting (19)	Cinema Houses (20)	Air Ports (21)	Nautical Ports (22)	Railways (23)	Misc. (24)	Total (25)
		400	120		10	20	50	10					1,210
		300	50				50	20			30		1,250
		300	40				50	10					625
					20		50						370
		300				20	30						350
45		300	200	60	20	100	108				350		2,283
		300	50		20	30	50	20			30		1,025
		300	100	50		20	50	20			30		2,295
		400	80		20	20		10				(*a*) 50	1,030
		400	60	20	20		50		10				1,235
		400	200	120	20	30		40					1,410
		300	320			30	130	40			30		1,263
		150	30		20	100		45		10	10	(*b*) 150	1,340
		400	60		10		30						725
		400			10		30	10				(*a*) 50	650
						50	50						335
		300				14	50						664
		50	50		20	120	54				20		539
		150	60	50	20	20	100				20		995
		400	180	140	30	30		60			200		2,590
		300	40			20	50	20			30		985
		300	50	30		30	50	15			30		1,380
		300			10	10	22						492
0		300	60		20	20		40			20		1,135
													150
		250			20		30	10					535
			25	20				30					300
0	50	375	375	178	50	10	100	40		100		(*c*) 54	3,037
													1,200
	150	150		18	5	10		15				(*d*) 75	683
													375
	500	710	200	90	10	60	210	45	15	10	10	(*e*) 99	3,509
													300
													825
													150
													225

TABLE XIX – 3 (*continued*) PUBLIC ELECTRIC SUPPLY

City or Town	*Rice Mills* (1)	*Oil Mills* (2)	*Saw Mills* (3)	*Wheat Mills* (4)	*Cotton Mills* (5)	*Dhall Mills* (6)	*Ice Factories* (7)	*Petroleum Refineries* (8)	*Sugar Refineries* (9)	*Weaving Factories* (10)	*Jail Industri* (11)
Kyangin	225		150								
Maubin	150										
Moulmeingyun	975										
Myanaung	450		75								
Myaungmya	975		113								100
Pantanaw	150										
Pyapon	1,200										
Wakema	600										
Yandoon	225	70	105			20					
Einme	150										
Kangyi											
Kwingauk	150										
Kyonmange	150										
Labutta	150										
Myingagon	150										
Mezaligon											
Ngathainggyaung	225										
Ngamyethna Pagoda (Henzada)											
Yegyi	225										
Tenasserim Division											
Kyaikto											
Mergui											
Moulmein											
Tavoy											
Thaton											
Kawkareik											
Mudon											
Palaw											
Magwe Division											
Allanmyo		650	100		1,000						
Magwe		75									20
Yenangyaung		500				100		5,000			
Pakokku		100	175				75			100	
Thayetmyo		100	50		100						20
Kama		20	73								
Minbu			100					300			
Salin	375										
Mandalay Division											
Amarapura		150		150						1,000	
Mandalay	825	1,275	1,275	900	150		225			260	
Maymyo											
Myingyan		1,150	150		1,000					100	
Meiktila					1,425	750					
Nyaungoo		150	100								20
Pyawbwe		75	75								
Pyinmana	375	75	150						500		
Yamethin			50						500		
Kyaukse	750	75	150	150							
Lewe	225	75	150						500		

(*d*) Bamboo Mat and Hat Factories (*f*) Smithy and Foundry

PECTIVE EXPANSION IN KILOWATTS

ge ies	Salt and Fish Industries (13)	Pump Stations (14)	Workshops (Auto Repairs) (15)	Printing Presses (16)	Military (17)	Pagoda Lighting (18)	Town Lighting (19)	Cinema Houses (20)	Air Ports (21)	Nautical Ports (22)	Railways (23)	Misc. (24)	Total (25)
		150										(*d*) 35	560
													150
													975
			35				50				10		620
		75											1,263
													150
													1,200
													600
		180		36		27		30					693
													150
													150
													150
	100												250
													150
													225
						22							22
													225
		20	160	100		20	50	20	20			(*f*) 130	2,270
		170			20	20		20	20				345
		1,000		125		50	100	20				(*g*) 75	6,970
		150	75	100	20	40	100		20			(*f*) 50	1,005
		350		35	20	30	50	20	20			(*h*) 20	815
		50		20		80	50	10					303
		300	10		20	50	50						830
		300	75		20	50	50	10					880
		200	120			60	100	20					1,800
			100	600	30	120	1,000	90	20	500	430	(*i*) 5,000	12,800
					50		200						250
		400	225					20			20		3,815
		400	80	60		20		20	20		250		2,275
		50				20		10				(*j*) 20	370
		400	120		20	10		20					720
		420		60		30		20				(*k*) 20	1,650
		400	80			20		20					1,070
		200						20			10		1,355
		400			20	20	22	10					1,422

g) Coffee Mills
h) Night Bazaar Stalls

(*i*) Cigarettes, Distillery, Electroplating, Tanning, Refrigeration and Air Conditioning

(*j*) Lacquer-ware Factories
(*k*) Forest School

TABLE XIX – 3 (*continued*) PUBLIC ELECTRIC SUPPLY

City or Town	*Rice Mills* (1)	*Oil Mills* (2)	*Saw Mills* (3)	*Wheat Mills* (4)	*Cotton Mills* (5)	*Dhall Mills* (6)	*Ice Factories* (7)	*Petroleum Refineries* (8)	*Sugar Refineries* (9)	*Weaving Factories* (10)	*Jail Industri* (11)
Sagaing Division											
Bhamo											
Katha											
Mogok											
Monywa											
Myitkyina											
Sagaing			105	375	3,750		50			100	
Shwebo	280	45		60							
Kawlin											
Federated Shan States											
Hsipaw											
Kyaukme											
Lashio											
Panghai E' Hang											
Taunggyi											
Namhsan											

d. Market Area

The project is intended primarily to serve the existing Rangoon–Insein market but would also serve Pegu–Henzada and other communities along the route of the proposed transmission line. The market area is bounded on the north by the Pegu Yomas, on the east by the Sittang River, on the south by the Rangoon River, and on the west by the Irrawaddy (see map on Plate 2). The population of the area is estimated to have been about 3,000,000 in 1952. The income in 1938–39, corrected for the price increase since that time, is estimated at K81 crores. Industrial plants in the Rangoon area include ice factories, flour mills, match factory, hosiery works, rubber works, broadcasting station, government docks, pumping plants and railway shops. One of the largest users of electricity is the government cotton spinning and weaving factory, completed in 1950, with 20,000 spindles and 200 looms. Other important users are the Burma Army, Secretariat, General Hospital, Rangoon University and domestic lighting which catalogued about 25,000 meters at the end of 1952. Plants under construction include a tile factory, sawmills and a soap factory. Existing development at Pegu and Henzada includes ice plants, soft drink bottling works, saw mills and a moderate lighting load.

e. Existing Power Development

The Rangoon power plant is a coal or oil-fired modern steam station having two new 10,000 kW generators, two inefficient old 2,500 kW generators and one damaged generator derated to 3,000 kW. An additional 10,000 kW generator will be in operation by mid-1956. The 1952 peak demand at the generators was 12,400 kW and the units generated totaled 46,500,000 kWh. The market growth is over 30% per annum in spite of the high rates, 50 pyas per kWh for domestic and 25 pyas for commercial. Plate 3 shows a typical daily load cuve for January 12, 1953. On Plates 4 and 5 are shown units generated in kWh per week and maximum demand in kW for Rangoon-Insein market. Plate 6 shows the present and projected sales and peak demand for the years 1948 to 1962. Existing development at other towns in the market area includes the following diesel plants owned and operated by the Electricity Supply Board.

	Plant Capacity in kW	*kWh per year sales (1951)*
1. Pegu	238	280,000
2. Tharrawaddy	130	
3. Letpadan	66	180,000
4. Henzada	130	

In the above communities power rates are 75 pyas per kWh and service is on a 6- to 12-hour basis daily.

ROSPECTIVE EXPANSION IN KILOWATTS

Cottage Industries (12)	Salt and Fish Industries (13)	Pump Stations (14)	Workshops (Auto Repairs) (15)	Printing Presses (16)	Military (17)	Pagoda Lighting (18)	Town Lighting (19)	Cinema Houses (20)	Air Ports (21)	Nautical Ports (22)	Railways (23)	Misc. (24)	Total (25)
		 350	100	36		150	50 50	20	20		500	(*l*) 200	5,806 435
					20		80 30						100 30

(*l*) Locomotive Workshop

f. Prospective Load

The principal power loads now anticipated for 1955 and 1960 are summarized below:

No.	Description	Demand in Kilowatts 1951	1955	1960
1.	Ice Plants	600	900	1,200
2.	Flour Mills	300	500	700
3.	Match Factory	100	150	200
4.	Hosiery Works	170	250	350
5.	Rubber Works	80	100	150
6.	Broadcasting Station	50	400	600
7.	Government Dockyard	90	100	100
8.	Spinning Mill	700	1,100	1,500
9.	Rangoon University (Pumping)	60	60	60
10.	Burma Railways	530	700	900
11.	Port Commissioners	70	80	90
12.	Miscellaneous	300	600	900
	Subtotal (Existing Bulk)	3,050	4,940	6,750
13.	Proposed Tile Factory	—	400	600
14.	,, Saw Mill	—	300	500
15.	,, Soap Factory	—	250	400
16.	,, Creosoting Plant	—	100	200
17.	,, Water Supply Pumps	(220)*	730	1,100
18.	,, Sewage Pumps	(82)*	300	600
19.	,, Steel Mill	—	4,500	7,500
	Subtotal (Exist. and Prop. Bulk)	3,050	11,520	17,650
20.	Burma Army	350	500	700
21.	Railway Office	80	100	100
22.	Sule Pagoda Wharf	60	60	60
23.	Secretariat	105	150	250
24.	Central Jail	70	100	100
25.	General Hospital	80	150	250
26.	University	85	100	100
27.	Misc. All Purpose	820	1,200	1,500
	Subtotal (Bulk and All purpose)	4,700	13,880	20,710
28.	Power	1,030	1,400	1,600
29.	Departmental	70	160	320
30.	Public Lighting	260	570	1,140
31.	Lighting	4,070	7,550	15,150
	Rangoon Load with Steel Mill	10,130	23,560	38,920
	Max. simultaneous demand at generators	9,400	21,900	36,000
32.	Pegu Lighting	238	438	550
33.	Hanthawaddy Lighting	Incomp.	244	343
34.	Tharrawaddy–Thonze Lighting	130	257	365
35.	Letpadan Lighting	66	114	172
36.	Henzada Lighting	130	600	732
37.	Ice Plants	—	165	200
38.	Pegu Sawmills	—	300	600
39.	Irrigation	—	4,000	8,000
	Outlying Towns Total	564	6,118	10,962
	Grand total incl. Rangoon	10,694	29,678	49,882
	Max. simultaneous demand at generators	9,900	27,500	46,000

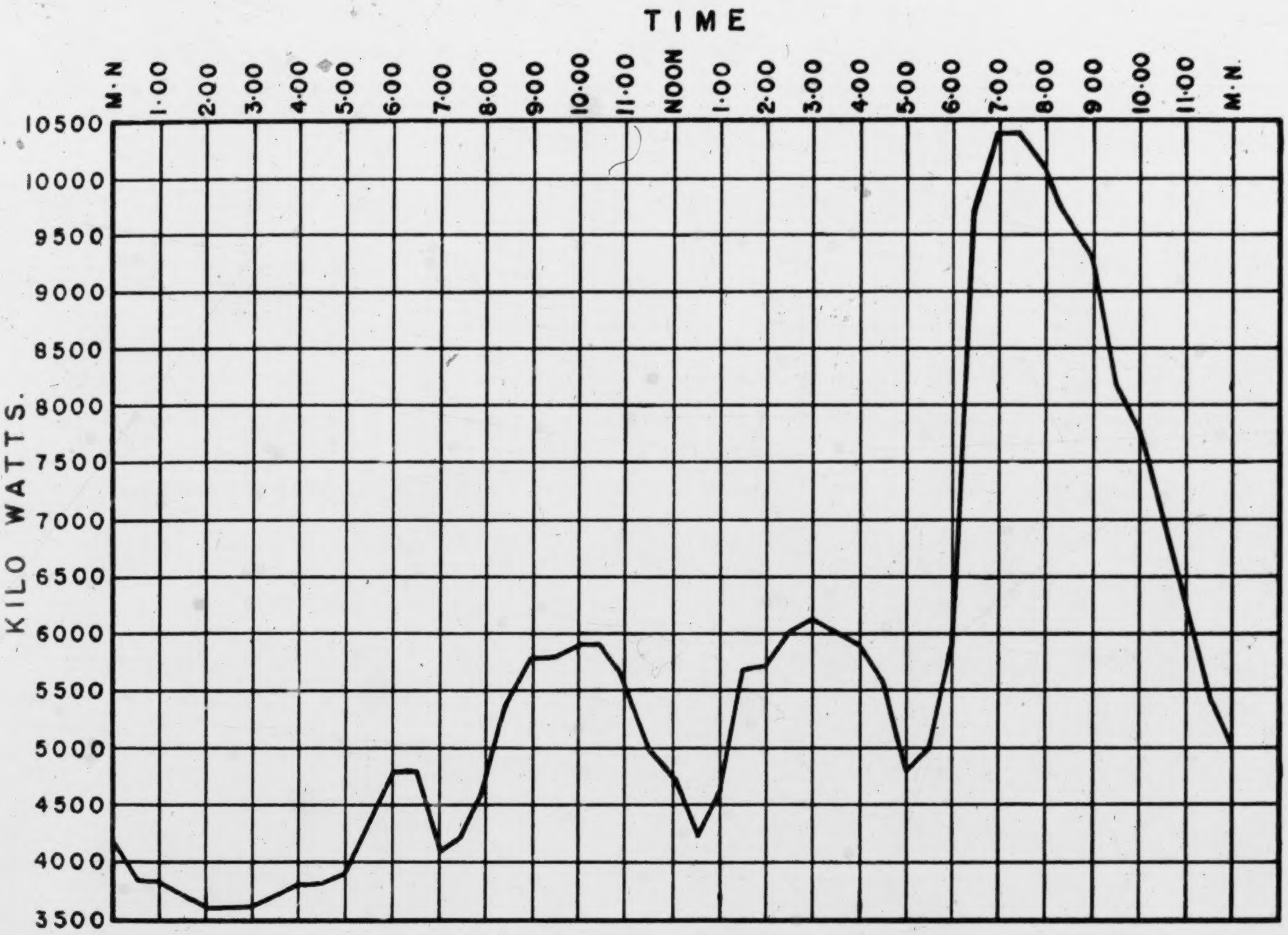
*Existing steam or air pumps.

For details of the above summary see Table XIX–5 "Estimated Power Requirements: Rangoon–Insein Metropolitan Area" and Table XIX–6 "Estimated Power Requirements: Lower Pegu Division and Henzada" (*see pages 577 & 579*).

TABLE XIX – 4

INITIAL DIESEL AND HYDRO PLANTS AT 36 TOWNS

Location	*Number and Capacity of Generating Sets*	*Estimated Cost in Thousand Kyats*						
		Generators Control Equipment, etc.	*Local Distribution*	*Step-up stns. and Rural Transmission*	*Step-down and Consumers' Substations*	*Rural Distribution*	*Freight, Vehicles, Buildings, etc.*	*Total*
1. Pegu	2 x 1,000	1,070	45	5,085	134	500	310	7,144
2. Pyinmana	2 x 1,000	1,070	45	6,345	134	600	312	8,506
3. Meiktila	3 x 1,000	1,590	45	6,231	168	400	335	8,769
4. Prome	2 x 1,000	1,070	45	4,695	127	403	312	6,649
5. Tharrawaddy	2 x 1,000	1,070	38	3,735	127	400	310	5,680
6. Henzada	2 x 500	605	38	5,775	113	400	301	7,232
7. Bassein	2 x 500	605	38	3,855	120	400	301	5,319
8. Maubin	2 x 250	348	14	1,538	78	300	245	2,523
9. Pyapon	2 x 250	348	14	1,538	78	300	245	2,523
10. Bogale	2 x 100	239	13	1,520	70	300	158	2,300
11. Kyaiklat	2 x 100	239	213	1,520	70	300	158	2,500
12. Magwe	2 x 500	605	31	1,485	110	400	302	2,932
13. Minbu	2 x 250	348	214	2,438	89	300	246	3,635
14. Pakokku	2 x 500	605	288	3,375	106	400	303	5,077
15. Kanpetlet	2 x 50	143	113	—	—	—	94	350
16. Shwebo	2 x 200	348	14	2,588	105	300	248	3,603
17. Monywa	3 x 100	359	263	3,030	79	250	103	4,074
18. Katha	2 x 250	348	214	6,038	105	300	228	4,233
19. Bhamo	2 x 250	348	214	3,038	105	300	228	4,233
20. Myitkyina	2 x 250	348	14	3,038	105	300	228	4,033
21. Homalin	2 x 50	143	113	—	—	—	94	350
22. Singkaling Hkamti	2 x 50	143	133	—	—	—	94	350
23. Mogok	(Existing Hydro to be surveyed for expansion)							—
24. Loikaw	2 x 50	143	113	614	49	100	114	1,133
25. Panghai E'hang (Namtu)	(Purchase from Burma Corporation Namtu)							
26. Akyab	2 x 250	348	14	1,538	104	300	229	2,533
27. Sandoway	2 x 250	348	14	1,538	104	300	229	2,533
28. Kyaukpyu	2 x 50	143	163	612	47	100	114	1,179
29. Ramree	2 x 50	143	163	612	47	100	114	1,179
30. Cheduba	2 x 50	143	163	612	47	100	114	1,179
31. Moulmein	Exists	—	—	3,038	92	300	66	3,496
32. Mergui	2 x 100	239	263	3,617	53	200	155	4,527
33. Tavoy	From Anglo-Burma Tin, Hpaungdaw, increase height of dam.	—	250	—	—	—	82	332
34. Victoria Point	2 x 50	143	163	—	—	—	95	401
35. Thaton	2 x 500	605	231	3,375	112	400	295	5,018
36. Bilugyun	2 x 100	239	263	—	—	—	115	617
		14,486	4,051	82,413	2,678	8,750	6,938	119,316



LOAD CURVE FOR MONDAY 12TH. JAN. 1953.

MINISTRY OF NATIONAL PLANNIG

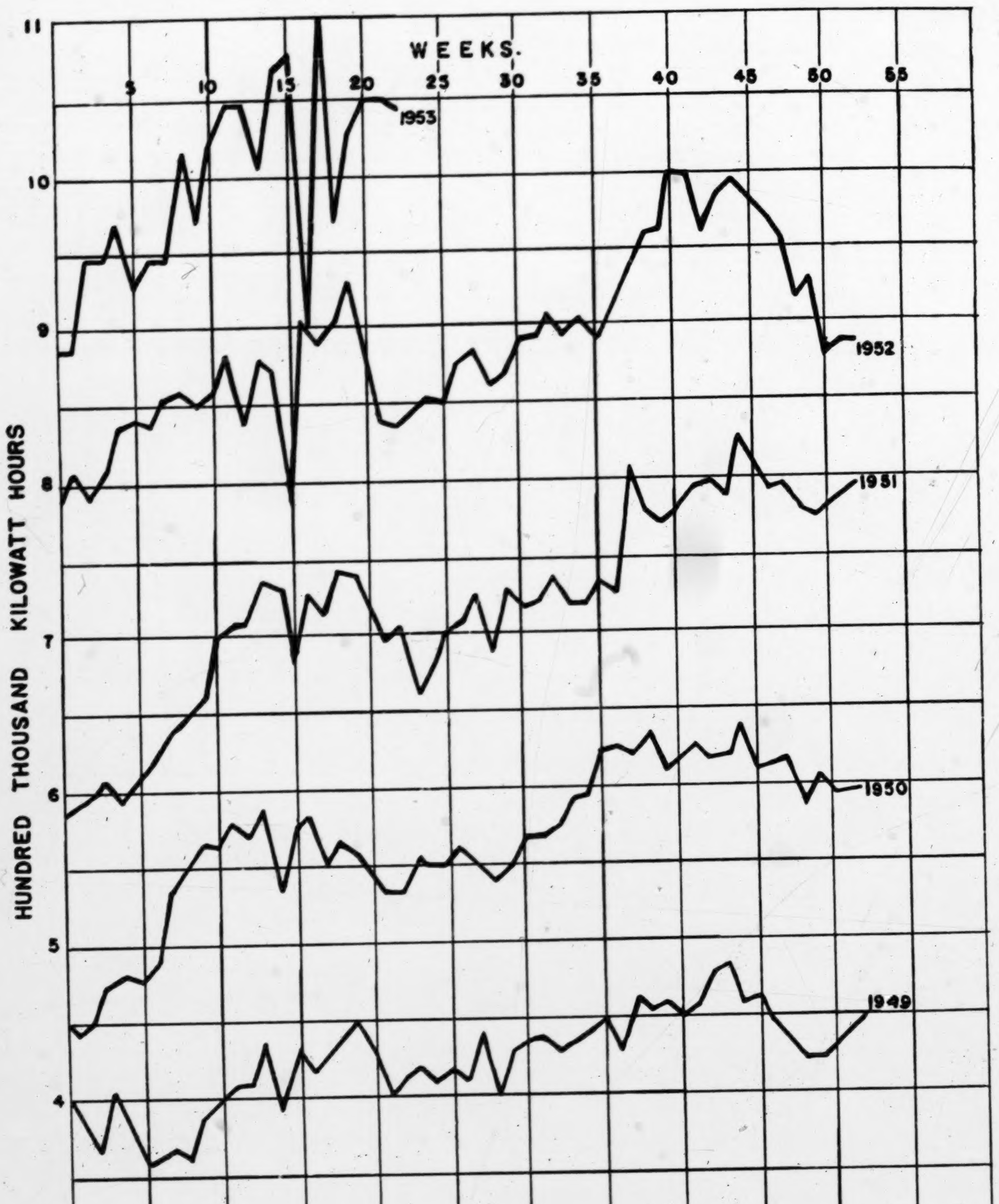
RANGOON – INSEIN MARKET

TYPICAL DAILY LOAD CURVE

MONDAY 12 JAN. 1953.

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR.BY. E.J.P. DATE PLATE
CK.BY. G.M.T. MAY, 53. NO. 3



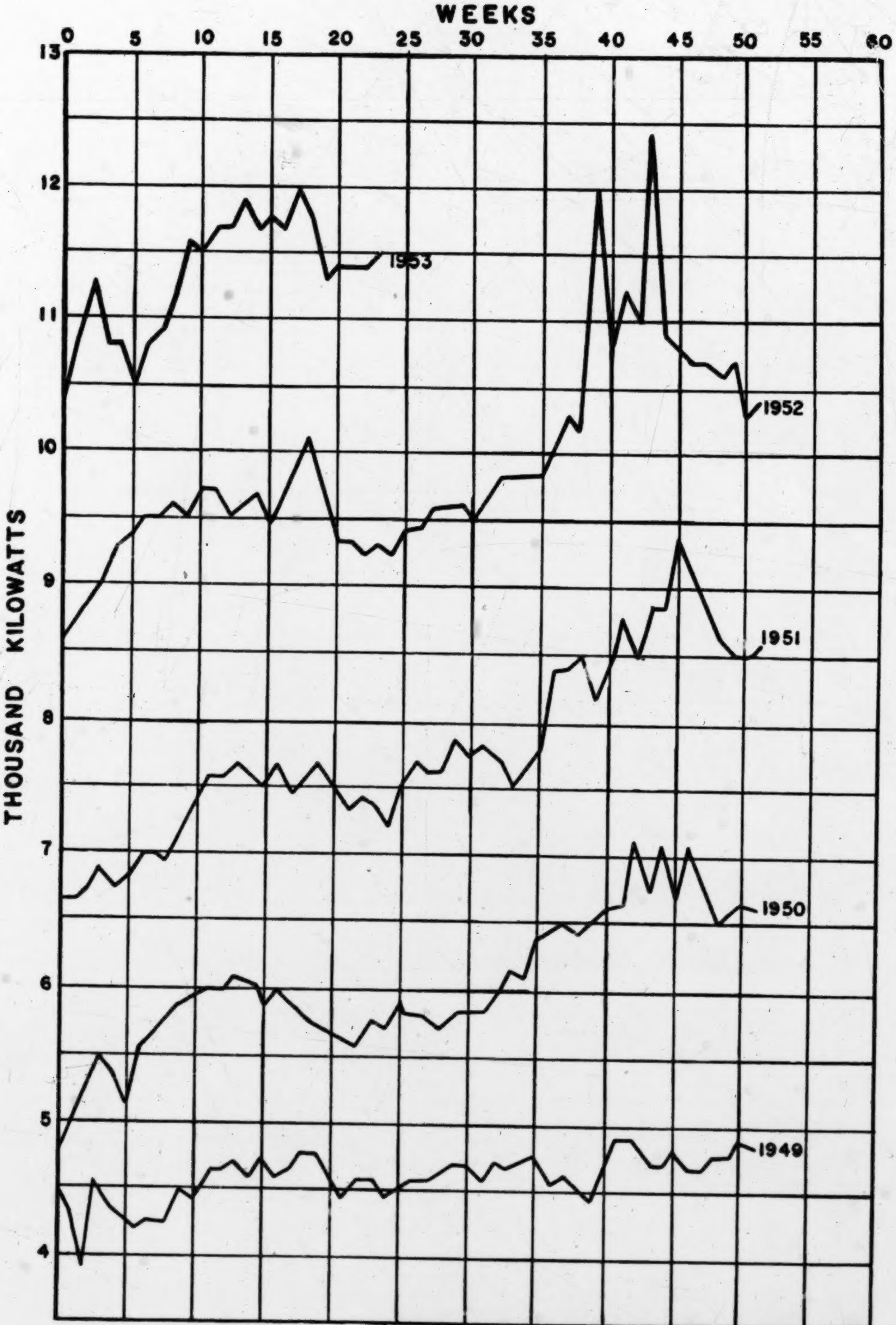
MINISTRY OF NATIONAL PLANNING

RANGOON — INSEIN MARKET

UNITS GENERATED IN KILOWATT HRS. PER WEEK

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. E.J.P. DATE PLATE
CK. BY. G.M.T. MAY, 53. NO. 4



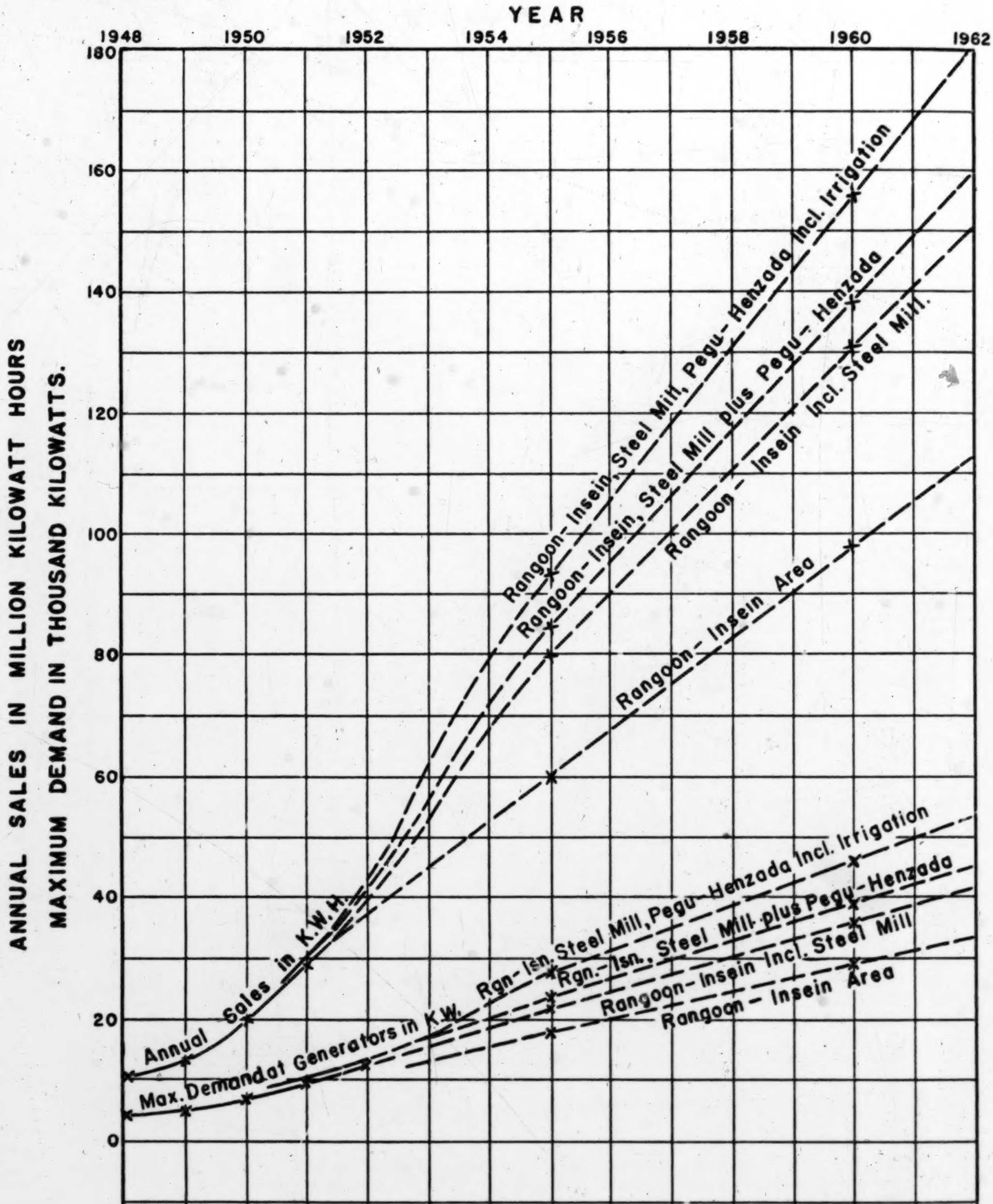
MINISTRY OF NATIONAL PLANNING

RANGOON — INSEIN MARKET

MAXIMUM DEMAND AT GENERATORS IN KILOWATTS

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P. DATE PLATE
CK. BY G.M.T. MAY, 53. NO. 5



MINISTRY OF NATIONAL PLANNING

LOWER PEGU DIVISION & HENZADA

POWER MARKET FORECAST

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR.BY E.J.P. DATE PLATE
CK.BY. GMT MAY, 53. NO. 6

TABLE XIX - 5 ESTIMATED POWER REQUIREMENTS—RANGOON-INSEIN METROPOLITAN AREA

	1951 (*Actual*)			1955 (*Estimated*)			1960 (*Estimated*)		
	kW Max. Demand	*Load Factor (%)*	*Thous. kWh per yr. Sales*	*kW Max. Demand*	*Load Factor (%)*	*Thous. kWh per yr. Sales*	*kW Max. Demand*	*Load Factor (%)*	*Thous. kWh per yr. Sales*
Existing Installations									
Ice Plants	600		2,290	900		3,550	1,200		5,350
Flour Mills	300		830	500		1,220	700		1,530
Match Factory	100		269	150		460	200		610
Hosiery Works	170		279	250		480	350		670
Rubber Works	80		341	100		510	150		770
Broadcast Station	50		118	400		740	600		1,480
Government Dockyard	90		186	100		240	100		240
Spinning Mill	700		2,050	1,100		2,450	1,500		2,760
Rangoon University Pumps	60		295	60		410	60		410
Burma Railways	530		960	700		1,290	900		1,650
Port Commissioners	70		99	80		120	90		130
Miscellaneous	300		844	600		1,730	900		2,310
Subtotal (Existing Bulk)	3,050	32	8,561	4,940	31	13,200	6,750	30	17,910
Proposed Installations									
Tile Factory			—	400		1,050	600		2,100
Saw Mill			—	300		700	500		1,750
Soap Factory			—	250		525	400		1,400
Creosoting Plant			—	100		440	200		880
Water Supply Pumps	*220	67	—	730		3,520	1,100		5,250
Sewage Pumps	*82	100	—	300		2,620	600		4,380
Subtotal	—	—	—	7,020	36	22,055	10,150	38	33,670
Steel Mill	—	—	—	4,500	50	19,700	7,500	50	32,800
Total (Existing and Proposed Bulk)	3,050	32	8,561	11,520	41	41,755	17,650	43	66,470
All Purpose Power									
Burma Army	350		1,340	500		2,230	700		3,120
Railway Office	80		256	100		370	100		370
Sule Pagoda Wharf	60		292	60		320	60		320
Secretariat	105		249	150		381	250		635
Central Jail	70		157	100		236	100		236
General Hospital	80		378	150		762	250		1,270
University	85		252	100		333	100		333
Miscellaneous	820		2,809	1,200		4,520	1,500		5,650
Subtotal (All purpose)	1,650		5,733	2,360		9,152	3,060		11,934
Power	1,030		4,051	1,400		6,100	1,600		7,000
Departmental	70		204	160		500	320		1,000
Public Lighting	260		665	570		2,500	1,140		5,000
Lighting	4,070		9,535	7,550		19,800	15,150		39,800
Total (Other than Bulk)	7,080	33	20,187	12,040	36	38,052	21,270	35	64,734
Population (thousands)			700			800			1,000
Annual kWh per capita	(lights)		14·6			28·0			44·8

* Existing air or steam pumps.

TABLE XIX – 5 (*continued*)

	1951 (*Actual*)			1955 (*Estimated*)			1960 (*Estimated*)		
	kW Max. Demand	*Load Factor (%)*	*Thous. kWh per yr. Sales*	*kW Max. Demand*	*Load Factor (%)*	*Thous. kWh per yr. Sales*	*kW Max. Demand*	*Load Factor (%)*	*Thous. kWh per yr. Sales*
Estimated Power Requirements—	*Bulk and*	*Other*							
Bulk without Steel Mill	3,050		8,561	7,020		22,055	10,150		33,670
Other than Bulk	7,080		20,187	12,040		38,052	21,270		64,734
Subtotal	10,130	32	28,748	19,060	36	60,107	31,420	36	98,404
Steel Mill	—		—	4,500		19,700	7,500		32,800
Total with Steel Mill	—		—	23,560	39	79,807	38,920	39	131,204
Max. simultaneous demand at generators	9,400	35†		17,700	39†		29,000	39†	
Ditto including Steel Mill	—			21,900	42†		36,000	42†	

† System load factor.

g. Comparison of Steam and Hydroelectric Power

The actual cost of energy per kWh of output is given in Table XIX–7 (*see p. 580*) for the existing Rangoon system. The cost includes fuel, labor, management, interest, depreciation and taxes for both generation and distribution based on detailed reports of the Rangoon Electric Tramway and Supply Company up to 1950 and based on preliminary accounting estimates from the same company for 1951. For future years a descending price per kWh is estimated in view of the relatively constant overhead charges and the anticipated market growth. The cost of power production by expanding the present steam plant or constructing a new steam plant in the Rangoon–Insein area has been compared with the cost of production by new hydroelectric stations. Four alternative markets were considered as follows:

(1) Rangoon–Insein area not including Steel Mill (see Table XIX–8, *see p. 581*)

(2) Rangoon–Insein area including new Steel Mill (see Table XIX–9, *see p. 582*)

(3) Rangoon–Insein area including Steel Mill plus lower Pegu Division and Henzada (see Table XIX–10, *see p. 583*)

(4) Rangoon–Insein area including Steel Mill plus lower Pegu Division and Henzada with Irrigation (see Table XIX–11, *see p. 584*)

Table XIX–11a (*see p. 585*) is included to show alternative (4) if the Pegu hydroelectric plant is constructed and all future expansion is accomplished by steam without the benefit of additional low cost hydroelectric power.

For each of the four alternatives hydroelectric power from the Pegu and Paunglaung projects is found to be more economical than power from a steam station. The hydroelectric estimates are necessarily conservative because of the dearth of physical data. It is possible that the cost of Pyas 4·5 per kWh for the Pegu River project (not including distribution costs) can be reduced by design and construction economies after field investigations have been completed. It is concluded that two 15,000 kW units should be installed initially in 1957, the earliest possible completion date for the hydroelectric plant, and that an additional 15,000 kW unit should be installed not later than 1959.

h. Paunglaung Hydroelectric Project

Construction of the initial Paunglaung River hydroelectric plant should be completed in 1960 in order to supply additional low cost power (Pyas 4·0 per kWh not including distribution costs) to the Mandalay and Rangoon power markets. Completion of upstream regulating dams will further reduce the cost of power from the initial hydroelectric station. Ultimately about 750,000,000 kWh annually can be made available from the Paunglaung projects at an average cost of about Pyas 3·5 per kWh. (See discussion of this project under paragraph G of this report, "Other Hydroelectric Projects for Future Development").

i. Bawgata Hydroelectric Project

The initial and ultimate costs for the Paunglaung project are about equal to those for the Bawgata project, for which a preliminary study is given in paragraph G. The former has irrigation and flood

TABLE XIX – 6

ESTIMATED POWER REQUIREMENTS
LOWER PEGU DIVISION AND HENZADA

	1951 (Actual)		*1955 (Estimated)*		*1960 (Estimated)*	
	Ann. kWh/cap.	*Population*	*Ann. kWh/cap.*	*Population*	*Ann. kWh/cap.*	*Population*
Pegu	7·0	40,000	15	51,000	20	60,000
Hanthawaddy	—	25,000	10	32,000	15	40,000
Tharrawaddy–Thonze	10·0	18,000	15	30,000	20	40,000
Letpadan	—	12,000	10	15,000	15	20,000
Henzada	—	60,000	15	70,000	20	80,000

Domestic Power Requirements

	*kW Max. Demand**	*Load Factor %*	*kWh per Yr. Sales*	*kW Max. Demand*	*Load Factor %*	*kWh per Yr. Sales*	*kW Max. Demand*	*Load Factor %*	*kWh per Yr. Sales*
Pegu	238	14	280,000	438	20	765,000	550	25	1,200,000
Hanthawaddy	—	—	—	244	15	320,000	343	20	600,000
Tharrawaddy–Thonze	130	16	180,000	257	20	450,000	365	25	800,000
Letpadan	66	—	—	114	15	150,000	172	20	300,000
Henzada	130	—	—	600	20	1,050,000	732	25	1,600,000
Total Domestic	564		Incomplete	1,653		2,735,000	2,162		4,500,000

Bulk Power Requirements

Pegu Ice			—	50	50	219,000	60	50	262,000
,, Saw Mills			—	300	40	1,050,000	600	40	2,100,000
Tharrawaddy–Letpadan Ice			—	45	50	198,000	60	50	262,000
Henzada Ice			—	70	50	306,000	80	50	350,000
Subtotal			—	465	—	1,773,000	800	—	2,974,000
Pegu Irrigation			—	1,300	25	2,850,000	2,600	25	5,700,000
Henzada Irrigation			—	2,700	25	5,910,000	5,400	25	11,820,000
Total Bulk			—	4,465		10,533,000	8,800		20,494,000

Combined Domestic and Bulk Power Requirements

Domestic	564		Incomplete	1,653		2,735,000	2,162		4,500,000
Bulk without Irrigation				465		1,773,000	800		2,974,000
Subtotal	564			2,118	24	4,508,000	2,962	29	7,474,000
Total incl. Irrigation				6,118	25	13,268,000	10,962	26	24,994,000
Max. simultaneous demand at generators				1,960	26		2,740	31	
Ditto including Irrigation.				5,670	27†		10,150	28†	

* Present installed capacity. † System load factor.

TABLE XIX – 7

COST OF ENERGY FROM ACCOUNTS OF RANGOON ELECTRIC TRAMWAY AND SUPPLY

	1948	*1949*	*1950*	*1951*
kWh Annual Output	16,908,861	19,725,411	25,407,837	33,666,901
	K	K	K	K
A. Generation Costs				
Fuel	13,31,016	21,35,709	24,00,254	1951 Costs are close estimate of actual expenses
Stores	38,162	47,023	39,751	
Salaries	1,17,293	1,17,985	1,36,603	
Wages	98,263	1,06,915	1,58,650	
Repairs and Maintenance	1,16,906	2,23,983	1,82,176	
Rents and Taxes	98,691	1,29,516	1,27,032	
Insurance	—	—	—	
Hire of Generating Plant	12,596	13,815	—	
Miscellaneous Expense	30,692	55,807	53,770	
Total Generation Costs	18,43,619	28,30,753	30,98,236	33,00,000
B. Distribution Costs				
Salaries	2,11,282	2,36,307	2,58,927	
Wages	81,159	75,447	62,468	
Mains, Repairs	1,88,115	2,23,076	2,39,282	
Transformers, Repairs	1,15,464	1,03,023	1,00,531	
Meters, Repairs	60,440	81,119	90,678	
Public Lamps, Repairs	44,855	73,681	67,232	
Total Distribution Costs	7,01,315	7,92,653	8,19,118	9,00,000
C. Administration Costs				
Agency Fees	1,80,752	2,32,424	3,29,938	
General Establishment	4,21,863	4,59,987	4,70,793	
Auditors' Fees	6,250	5,500	5,500	
Hire of Assets	1,34,044	1,53,891	4,39,277	
Business Premises Tax	—	—	58,332	
General Misc. Expense	456	2,006	7,381	
Total Administration Costs	7,43,365	8,53,808	13,11,221	16,00,000
60% to Generation*	4,46,000	5,12,000	7,86,000	9,60,000
40% to Distribution	2,97,365	3,41,808	5,25,221	6,40,000
D. Depreciation Costs			(Oct.-Dec.)	
Buildings	—	—	(24,212)	
Plant	—	—	(1,49,134)	
Mains	—	—	(41,262)	
Transformers	—	—	(7,192)	
Motors	—	—	(18,379)	
Motor Vehicles	—	—	(21,373)	
Total Depreciation	4,38,815	5,71,341	8,72,478	12,00,000
60% to Generation*	2,63,000	3,43,000	5,24,000	7,20,000
40% to Distribution	1,75,815	2,28,341	3,48,478	4,80,000
Cost of Generation				
A+60% of C & D	K25,52,619	K36,85,753	K44,08,236	K49,80,000
Cost per kWh Output	Pyas 15·10	Pyas 18·70	Pyas 17·30	Pyas 14·75
Cost of Distribution				
B+40% of C & D	K11,74,495	K13,62,802	K16,92,817	K20,20,000
Cost per kWh Output	Pyas 7·00	Pyas 6·90	Pyas 6·70	Pyas 6·00
Total Costs A+B+C+D	K37,27,113	K50,48,555	K61,01,153	K70,00,000
Cost per kWh Output	Pyas 22·10	Pyas 25·60	Pyas 24·00	Pyas 20·75

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* Proportionate to the investment.

control benefits in addition to power whereas the latter provides power only. The Paunglaung project does not involve flooding villages or farm lands whereas Bawgata is objectionable because of such damages. Accordingly it is concluded that the Bawgata field investigations and construction should be deferred until the Paunglaung project is completed or well advanced.

j. Early Completion of Hydroelectric Projects

By reference to Table XIX–8 it may be seen that the estimated cost of energy produced by steam plants located in the Rangoon area (including distribution costs) varies from Pyas 20 per kWh in 1952 to about Pyas 16·4 in 1962. By the addition of the Pegu hydroelectric plant in 1958 the average cost of energy can be reduced from Pyas 17·6 (steam alone) to Pyas 12·5 (steam and hydroelectric combined). By the addition of the Paunglaung hydroelectric plant in 1962 the average cost can be reduced from Pyas 16·4 (steam alone) to Pyas 11·8 (steam and hydroelectric combined). The above comparisons are made

TABLE XIX–8

ESTIMATED COST OF ENERGY, RANGOON–INSEIN METROPOLITAN AREA

Without Steel Mill

	1952	*1956*	*1958*	*1960*	*1962*
Annual Sales, Thousands kWh	37,000	68,000	83,000	98,000	114,000
Annual Output, Thousands kWh	42,500	78,300	95,500	112,500	131,000
Maximum Demand, kW	12,400	20,000	25,000	29,000	34,000
Steam Plant, 10,000-kW units	2	3	3	4	4
Steam Plant Capacity, kW	25,000	35,000	35,000	45,000	45,000
Steam Generation Costs, Pyas per per kWh	14·35	13.40	11·80*	11·20*	10·60*
Steam Distribution Costs, Pyas per kWh	5·75	5·75	5·75	5·75	5·75
Total Cost by Steam†	20·10	19·15	17·55	16·95	6·35
Pegu Hydroelectric Plant, kW	—	—	30,000	30,000	45,000
Pegu Hydroelectric Output, Thous. kWh	—	—	95,500	112,500	131,000
Pegu Generation Cost, Pyas per kWh	—	—	5·54	4·71	5·10
Pegu Generation per year, Thous. Kyats	—	—	5,290	5,290	6,680
Steam Plant, 10,000-kW units	2	3	3	3	3
Steam Plant Capacity, kW	25,000	35,000	35,000	35,000	35,000
Steam Output, Thous. kWh	42,500	78,300	0	0	0
Steam Generation Cost, Pyas per kWh	14·35	13·40	—	—	—
Steam Generation per year, Thous. Kyats	6,100	10,500	1,200‡	1,200‡	1,200‡
Total Generation Cost	6,100	10,500	6,490	6,490	7,880
Generation Cost, Pyas per kWh	14·35	13·40	6·79	5·77	6·02
Distribution Cost, Pyas per kWh	5·75	5·75	5·75	5·75	5·75
Total Cost by Steam and Hydro-electric†	20·10	19·15	12·54	11·52	11·77

* Kalewa coal available at K72.00 per ton. † Cost per kWh of output. ‡ Interest, depreciation and maintenance on idle steam plant.

for the Rangoon–Insein market without the steel mill development. The sale of large amounts of steam power renders the 1962 comparisons slightly less favorable to the combined steam and hydroelectric scheme when the steel mill is included and the Pegu–Henzada markets are added (see Table XIX–11). If the larger markets are to be served economically the hydroelectric projects should be completed as soon as possible.

k. Recommendation of Pegu Plant

The proposed Pegu hydroelectric project is a moderate-cost development with a relatively short transmission line to maintain and protect from

TABLE XIX – 9

ESTIMATED COST OF ENERGY, RANGOON–INSEIN METROPOLITAN AREA

Including Steel Mill

	1952	*1956*	*1958*	*1960*	*1962*
Annual Sales, Thous. kWh	37,000	90,500	110,500	131,000	151,000
Annual Output, Thous. kWh	42,500	104,000	127,000	151,000	174,000
Maximum Demand, kW	12,400	25,000	30,500	36,000	41,500
Steam Plant–10,000-kW units	2	3	4	4	5
Steam Plant–Capacity, kW	25,000	35,000	45,000	45,000	55,000
Steam Generation Costs–Pyas per kwWh	14.35	13·10	11·50*	10·90*	10·25*
Steam Distribution Costs–Pyas per kWh	5·75	5·75	5·75	5·75	5·75
Total Cost by Steam†	20·10	18·84	17·25	16·65	16.00
Pegu Hydro Plant, kW	—	—	30,000	45,000	45,000
Pegu Hydro Output, kWh	—	—	118,000	139,000	139,000
Pegu Generation Cost, Pyas per kWh	—	—	4·48	4·80	4·80
Pegu Generation Cost, per year Thousand Kyats	—	—	5,290	6,670	6,670
Paunglaung Hydro Plant, kW	—	—	—	—	40,000
Paunglaung Output for Rangoon–Thousand kWh	—	—	—	—	35,000
Paunglaung Generation Cost, Pyas per kWh	—	—	—	—	4·00
Paunglaung Generation Cost, Pyas per year Thousand Kyats	—	—	—	—	1,400
Steam Plant, 10,000-kW units	2	3	3	3	3
Steam Plant, Capacity, kW	25,000	35,000	35,000	35,000	35,000
Steam Output, Thousand kWh	42,500	104,000	9,000	12,000	0
Steam Generation Cost, Pyas per kWh	14·35	13·10	16·50*	16·00*	—
Steam Generation Cost, per year, Thousand Kyats	6,110	13,620	1,490	1,920	1,200‡
Total Generation Cost– Thousand Kyats	6,110	13,620	6,780	8,590	9,270
Generation Cost, Pyas per kWh	14·35	13·10	5·31	5·70	5·33
Distribution Cost, Pyas per kWh	5·75	5·75	5·75	5·75	5·75
Total Cost by Steam and hydro-electric†	20·10	18·85	11·06	11·45	11·08

* Kalewa coal available at K72.00 per ton.

† Cost per kWh of output.

‡ Interest, depreciation and maintenance on idle steam plant.

TABLE XIX – 10

ESTIMATED COST OF ENERGY, RANGOON–INSEIN METROPOLITAN AREA

Including Steel Mill plus Lower Pegu Division and Henzada, without Irrigation Pumping

	1952	*1956*	*1958*	*1960*	*1962*
Annual Sales, Thous. kWh	38,000	95,000	117,000	138,000	160,000
Annual Output, Thous. kWh	42,500	109,000	134,500	159,000	184,000
Max. Demand, kW	13,000	26,500	33,000	39,000	45,000
Steam Plant, 10,000-kW units	2	3	4	4	5
Steam Plant Capacity, kW	25,000	35,000	45,000	45,000	55,000
Generation Cost, Pyas per kWh	14·35	13·10	11·40*	10·80*	10·10*
Distribution Cost, Pyas per kWh	5·75	5·75	5·75	5·75	5·75
Total Cost by Steam†	20·10	18·85	17·15	16·55	15·85
Pegu Hydro Plant, kW	—	—	30,000	45,000	45,000
Pegu Hydro Output, Thous. kWh	—	—	118,000	139,000	139,000
Pegu Hydro Generation Cost, Pyas per kWh	—	—	4·48	4·80	4·80
Pegu Generation Cost, per year, Thous. Kyats	—	—	5,290	6,670	6,670
Paunglaung Hydro Plant kW	—	—	—	—	40,000
Paunglaung Output for Rangoon Thous. kWh	—	—	—	—	40,000
Paunglaung Generation Cost, Pyas per kWh	—	—	—	—	4·00
Paunglaung Generation Cost, per year, Thous. Kyats	—	—	—	—	1,600
Steam Plant, 10,000-kW units	2	3	3	3	3
Steam Plant, Capacity, kW	25,000	35,000	35,000	35,000	35,000
Steam Output, Thous. kWh	43,500	109,000	16,500	20,000	5,000
Steam Generation Cost, Pyas per kWh	14·35	13·10	16·00*	15·50*	—
Steam Generation Cost, per year, Thous. Kyats	6,240	14,280	2,640	3,100	1,250‡
Total Generation Cost, Thous. Kyats	6,240	14,280	7,930	9,770	9,520
Generation Cost, Pyas per kWh	14·35	13·10	5·90	6·15	5·19
Distribution Cost, Pyas per kWh	5·75	5·75	5·45§	5·45§	5·45§
Total Cost by Steam and hydro-electric	20·10	18·85	11·35	11·60	10·64

* Kalewa coal available at K72.00 per ton.
† Cost per kWh output.
‡ Interest, depreciation and maintenance on idle steam plant govern cost for small output.
§ Transmission line expense to Pegu, Tharrawaddy, Henzada, included in hydroelectric generation costs.

vandalism. It is planned to serve Rangoon primarily with supplemental benefits to Pegu, Henzada, and other communities in the market area. For each combination of power markets investigated the Pegu project shows substantial economy over supplying the same market by expansion of the present steam station or construction of a new steam station. The Pegu project lends itself to incorporation in a more extensive power system connected to the proposed Paunglaung River project, but until the latter is

TABLE XIX – 11

ESTIMATED COST OF ENERGY RANGOON–INSEIN METROPOLITAN AREA

Including Steel Mill plus Lower Pegu Division and Henzada with Irrigation Pumping

	1952	*1956*	*1958*	*1960*	*1962*
Annual Sales, Thous. kWh	38,000	106,000	130,000	156,000	181,000
Annual Output, Thous. kWh	43,500	122,000	149,500	179,500	208,000
Max. Demand, kW	13,000	31,000	38,500	46,000	53,500
Steam Plant, 10,000-kW units	2	3	4	5	6
Steam Plant Capacity, kW	25,000	35,000	45,000	55,000	65,000
Generation Cost, Pyas per kWh	14·35	12·85	11·05*	10·45*	9·82*
Distribution Cost, Pyas per kWh	5·75	5·75	5·75	5·75	5·75
Total Cost by Steam†	20·10	18·60	16·80	16·20	15·57
Pegu Hydro Plant, kW	—	—	30,000	45,000	45,000
Pegu Hydro Output, Thous. kWh	—	—	118,000	139,000	139,000
Pegu Generation Cost, Pyas per kWh	—	—	4·48	4·80	4·80
Pegu Generation Cost, per year, Thous. Kyats	—	—	5,290	6,670	6,670
Paunglaung Hydro Plant kW	—	—	—	—	40,000
Paunglaung Output for Rangoon, Thous. kWh	—	—	—	—	40,000
Paunglaung Generation Cost, Pyas per kWh	—	—	—	—	4·00
Paunglaung Generation Cost, per year, Thous. Kyats	—	—	—	—	1,600
Steam Plant, 10,000-kW units	2	3	3	3	3
Steam Plant Capacity, kW	25,000	35,000	35,000	35,000	35,000
Steam Output, Thous. kWh	43,500	122,000	31,500	40,500	29,000
Steam Generation Cost, Pyas per kWh	14·35	12·85	14·40*	14·00*	14·00*
Steam Generation Cost, per year, Thous. Kyats	6,240	15,680	4,540	5,670	4,060
Total Generation Cost, Thous. Kyats	6,240	15,680	9,830	12,340	12,330
Generation Cost, Pyas per kWh	14·35	12·85	6·56	6·90	5·95
Distribution Cost, Pyas per kWh	5·75	5·75	5·45§	5·45§	5·45§
Total Cost by Steam and Hydro-electric†	20·10	18·60	12·01	12·35	11·40

* Kalewa coal available at K72.00 per ton.

† Per kWh of output.

§ Transmission line expense to Pegu, Tharrawaddy, Henzada, included in hydroelectric generation costs.

constructed the Pegu plant will function efficiently in serving the fast growing Rangoon market. Both steam and hydroelectric power are essential in the near future, the former to operate as a base load plant where it will be relatively efficient and the latter to carry base load and peaks, being equally efficient for either purpose. Accordingly it is recommended that field investigations for the Pegu site be completed as soon as possible and construction be scheduled for 1957 completion.

I. Technical Details

(1) Rainfall

For eight stations in the Pegu Division the annual rainfall is shown on Table XIX–12 (*see p. 586*), for the period of record, 1901 to 1952 inclusive except for the

TABLE XIX – 11a

ESTIMATED COST OF ENERGY RANGOON–INSEIN METROPOLITAN AREA

Including Steel Mill plus Lower Pegu Division and Henzada with Irrigation Pumping

Assuming no future hydroelectric development after completion of the Pegu River development

	1958	*1960*	*1962*	*1964*	*1966*
Annual Sales, Thous. kWh	130,000	156,000	181,000	206,000	232,000
Annual Output, Thous. kWh	149,500	179,500	208,000	237,000	267,000
Max. Demand, kW	38,500	46,000	53,500	61,000	68,500
Steam Plant, 10,000-kW units	4	5	6	7	8
Steam Plant Capacity	45,000	55,000	65,000	75,000	80,000*
Generation Cost, Pyas per kWh	11·05	10·45	9·82	9·30	8·90
Distribution Cost, Pyas per kWh	5·75	5·75	5·75	5·75	5·75
Total Cost by Steam†	16·80	16·20	15·57	15·05	14·65
Pegu Hydro Plant, kW	30,000	45,000	45,000	45,000	45,000
Pegu Output, Thous. kWh	118,000	139,000	139,000	139,000	139,000
Pegu Generation Costs, Pyas per kWh	4·48	4·80	4·80	4·80	4·80
Pegu Generation per year, Thous. Kyats	5,290	6,670	6,670	6,670	6,670
Steam Plant, 10,000-kW units	3	3	3	3	4*
Steam Plant Capacity, kW	35,000	35,000	35,000	35,000	40,000
Steam Output, Thous. kWh	31,500	40,500	69,000	98,000	128,000
Steam Generation Cost, Pyas per kWh	13·40	13·00	12·20	11·30	10·30
Steam Generation per year, Thous. Kyats	4,420	5,270	8,420	11,070	13,180
Total Generation Cost, Thous. Kyats	9,710	11,940	15,090	17,740	19,850
Generation Cost, Pyas per kWh	6·36	6·67	7·27	7·50	7·45
Distribution Cost, Pyas per kWh‡	5·45	5·45	5·45	5·45	5·45
Total Cost by Steam and Hydro-Electric†	11·81	12·12	12·72	12·95	12·90

* Discard old 2,500 kW sets.
† Per kWh of output using Kalewa coal at K72.00 per ton.
‡ Transmission line expense to Pegu, Tharrawaddy, Henzada included in hydroelectric generation costs.

years 1939 to 1945. The data were obtained from the Burma Meteorological Department. Three of the stations (Tharrawaddy, Pegu and Nyaunglebin) are believed to approximate the rainfall over the watershed more closely than the others, in view of the high altitude of the drainage area, averaging about 1,000 ft. above the rainfall stations, and in view of the large water supply measured at Pegu Iron Bridge, where river discharge records are available for the period 1946 to 1952. Accordingly these three stations have been selected for the rainfall duration curves shown on Plate 7. The relative position of the 1946–1952 rainfall at Pegu is also shown thereon. It is apparent from examination of the table and plate that the year 1951 is a controlling year in determining the minimum annual outflow at the iron bridge and probably at the dam site. It is probable that the low yield for 1951 was equalled in 1906, and even lesser yields were obtained in 1902, 1910 and 1913. During such infrequent years the steam station at Rangoon would be called upon to supply the slight deficiency. The 1951 yield, less 5% for a possible error in stream flow measurements, is used for computing firm power and for constructing the stage-discharge curve.

TABLE XIX – 12

PEGU RIVER HYDROELECTRIC PROJECT

Annual, Daily Maximum Rainfall in Inches at Selected Stations

Year	*Gyobin-gauk*	*Minhla*	*Tharra-waddy*	*Taikkyi*	*Pegu*	*Nyaung-lebin*	*Kyauk-taga*	*Pyu*
1901	61·7	*55·3	79·5		123·9	126·1		
1902	63·4	*66·9	83·3		106·7	98·8		
1903	57·9	70·5	86·3		126·2	130·7		
1904	67·9	83·7	87·3		153·4	142·8		
1905	65·4	83·8	91·6		150·8	149·4		
1906	63·4	67·8	71·0		112·5	122·2		
1907	72·0	73·4	89·1		129·9	138·1		
1908	71·8	75·7	83·5		143·9	147·5		102·7
1909	60·0	82·5	103·1		132·8	130·0		116·9
1910	69·3	108·1	84·2		110·1	117·1		88·0
1911	59·3	69·9	90·0		150·7	111·8		106·4
1912	66·6	70·9	84·0		116·4	134·1		99·0
1913	61·6	75·8	80·8		111·1	118·1		104·4
1914	64·8	71·9	115·0		132·5	118·3		143·3
1915	61·4	79·9	89·1	101·1	140·5	118·0	121·8	139·7
1916	62·8	91·0	94·6	94·7	120·6	103·5	100·9	122·4
1917	63·8	99·8	86·4	97·6	127·9	113·3	116·5	125·6
1918	71·7	95·2	87·0	101·8	116·1	136·7	127·4	179·2
1919	51·1	79·0	83·1	100·2	122·8	113·9	118·1	168·1
1920	50·5	64·4	82·9	100·1	132·8	110·4	114·4	87·5
1921	57·5	71·0	89·7	106·1	157·5	132·9	121·6	120·1
1922	48·9	75·3	104·5	104·6	125·2	168·0	149·7	144·1
1923	53·1	89·9	85·2	103·1	139·7	157·9	136·1	99·9
1924	60·2	92·8	95·0	103·6	141·8	154·0	126·4	109·8
1925	56·5	74·4	91·0	101·7	136·8	114·8	109·4	107·7
1926	59·2	74·3	96·0	98·9	118·3	140·8	114·3	104·9
1927	63·7	78·5	89·8	105·8	118·9	146·2	147·1	106·7
1928	49·9	77·2	78·1	116·4	123·3	143·6	142·2	102·5
1929	62·3	89·0	106·6	112·5	119·1	153·8	160·0	123·4
1930	84·7	82·2	92·8	115·8	139·8	150·6	128·2	105·2
1931	48·9	64·4	82·9	91·4	146·6	116·7	106·3	84·4
1932	53·9	66·4	75·2	81·3	135·5	125·6	134·8	130·9
1933	68·3	74·1	99·0	98·2	127·8	126·3	136·6	117·5
1934	56·6	68·7	76·8	96·4	124·5	137·7	156·2	123·3
1935	53·3	78·5	81·7	99·5	128·5	148·0	129·5	126·1
1936	59·5	76·1	92·0	100·2	142·0	122·3	122·0	120·4
1937	76·8	88·3	99·8	124·7	156·8	185·8	147·8	142·5
1938	70·5	70·5	85·8	101·4	123·4	115·6	137·2	133·3
1946				136·4				
1947				104·2				
1948	63·2	76·8	109·8	112·5	129·2	100·4	112·6	95·6
1949					131·0			
1950					123·3			
1951	66·0	84·8	82·8	96·9	113·3	107·7		
1952	70·7	98·3	98·9	120·7	144·5	135·3		98·6
Average	62·2	78·4	89·5	105·0	130·6	131·0	128·7	114·0
Max.Day			4·74		†14·2			

*At Okpo near Minhla.
†At Rangoon.

(2) Stream Flow

Daily gauge heights from June to October inclusive for 1946 to 1952 are available for the iron bridge at Pegu Town. The gauge was installed and current meter measurements were made by experienced personnel of the Irrigation Department regularly stationed at Pegu. Daily gauge readings were made by the same organization. The stage-discharge curve is given on Plate 8. Based on the gauge heights and rating curve, runoff for each year of record has been estimated and the following runoff factors based on the Pegu rainfall spread over the entire watershed above the iron bridge have been determined.

Year	*Computed Runoff Factor*
1946	70·6*
1947	66·2*
1948	58·0
1949	49·5
1950	52·8
1951	62·6
1952	65·1

*Based on Taikkyi rainfall instead of Pegu.

(3) Regulated Flow

Table XIX–13 (*see p. 591*) and Plate 9 contain a study of seven years of stream flow records, 1946 to 1952 inclusive. The computed runoff modified by storage would have yielded a minimum of 1,580,000 acre feet per year. After deducting evaporation an average daily flow of 2,120 cusecs could have been maintained for the period of record except in 1902, 1910 and 1913, using 985,000 acre feet of reservoir capacity. As shown on the Area-capacity Curve (Plate 10) the drawdown from top of spillway crest gates to minimum reservoir would have been 42 ft. in order to utilize the stored water. Plate 9 shows graphically the information given in Table XIX–13.

(4) Firm Power

Continuous firm power is computed as follows:

Pool Elev. 280 ft. Tailwater Elev. 120 ft. Gross Head 160 ft.

Average Head 160 – 21 = 139 ft. Net Head (95%) = 132 ft.

Continuous Power*

$$\cdot 95 \times 2{,}120 \times \frac{132}{15} = 17{,}700 \text{ kW}$$

Initial Output

30,000 kW @ 50% station capacity factor

15,000 × 8,760 = 131,000,000 kWh at station

·9 × 131,000,000 = 118,000,000 kWh at load center

Ultimate Output†

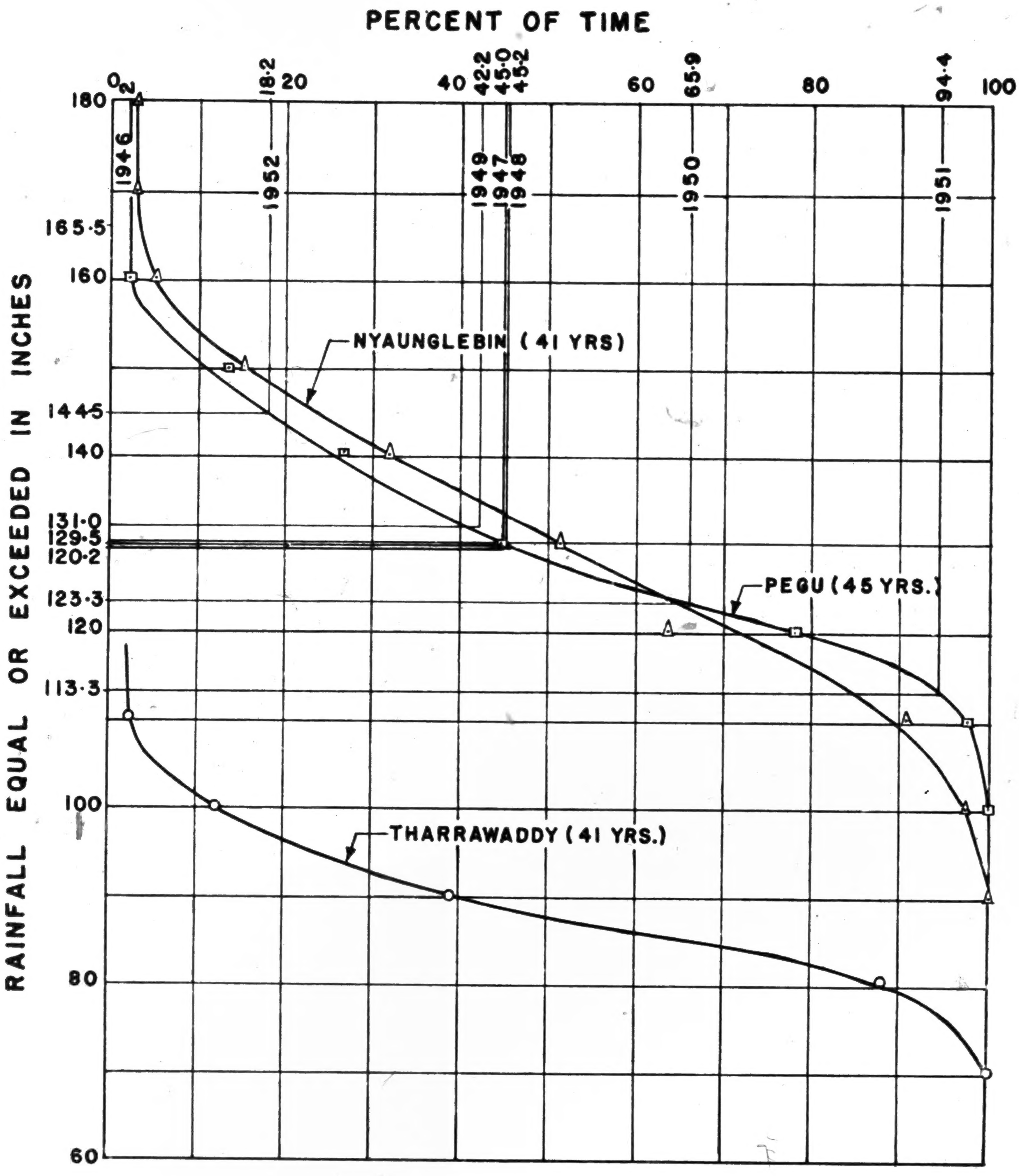
45,000 kW @ 39% station capacity factor

17,700 × 8,760 = 155,000,000 kWh at station

·9 × 155,000,000 = 139,000,000 kWh at load center

*The average daily flow is reduced by 5% to allow for possible error in constructing the stage-discharge curve.

†A fourth unit of 15,000 kW would be added at some future date if justified by the water supply or capacity factor.



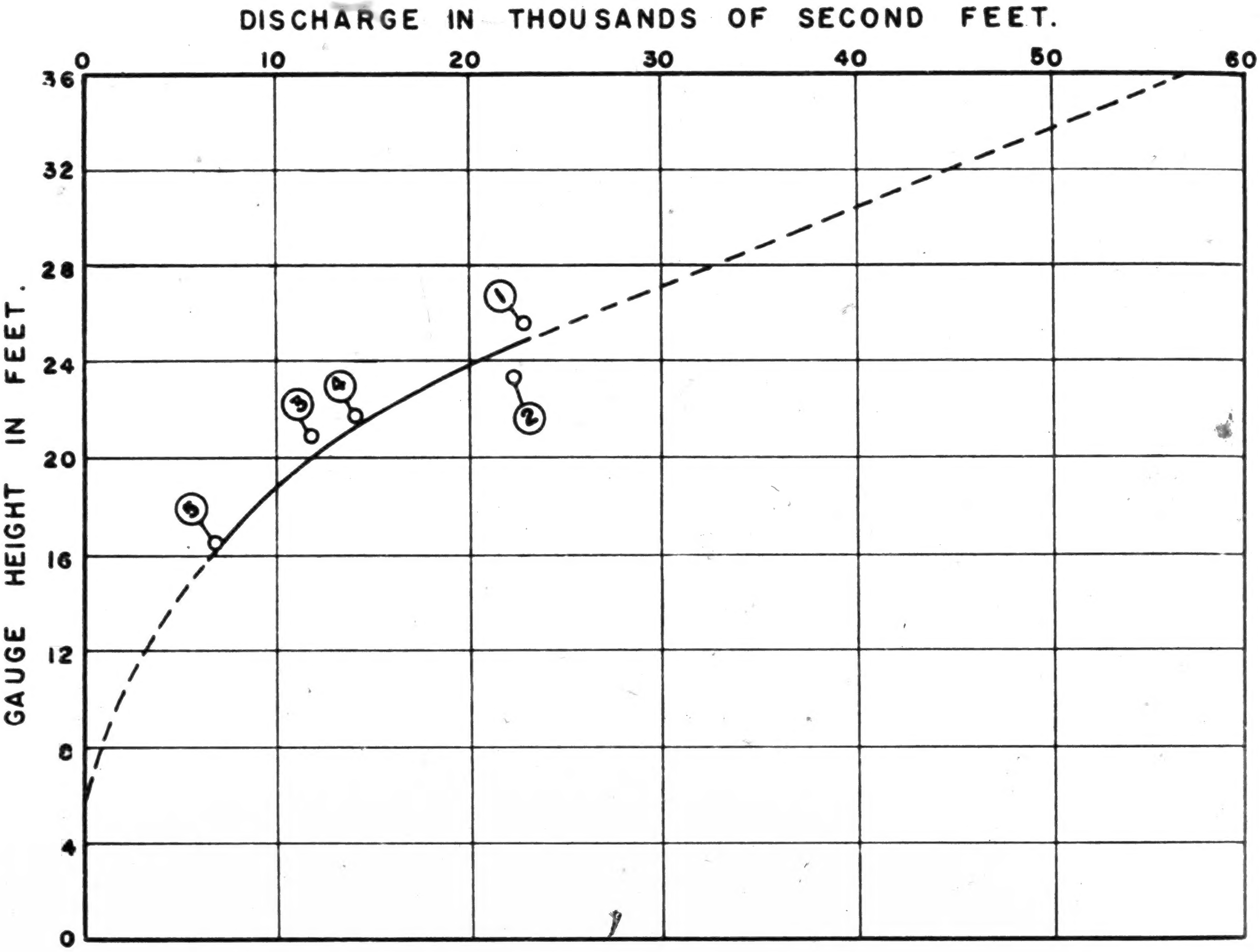
MINISTRY OF NATIONAL PLANNING

ANNUAL RAINFALL AT PEGU
THARRAWADDY AND NYAUNGLEBIN

RAINFALL DURATION CURVES

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. E. J. P. DATE PLATE
CK. BY. GMT MAY, 53. NO. 7



NO.	DATE	GAUGE READING	DIS-CHARGE	RIVER STAGE
1	27-8-52	25.5	22,984	FALLING
2	31-8-52	23·4	22,644	STATIONARY
3	12-9-52	21·0	12,096	FALLING
4	19-9-52	21·8	14,255	RISING
5	26-9-52	16·5	6,984	RISING

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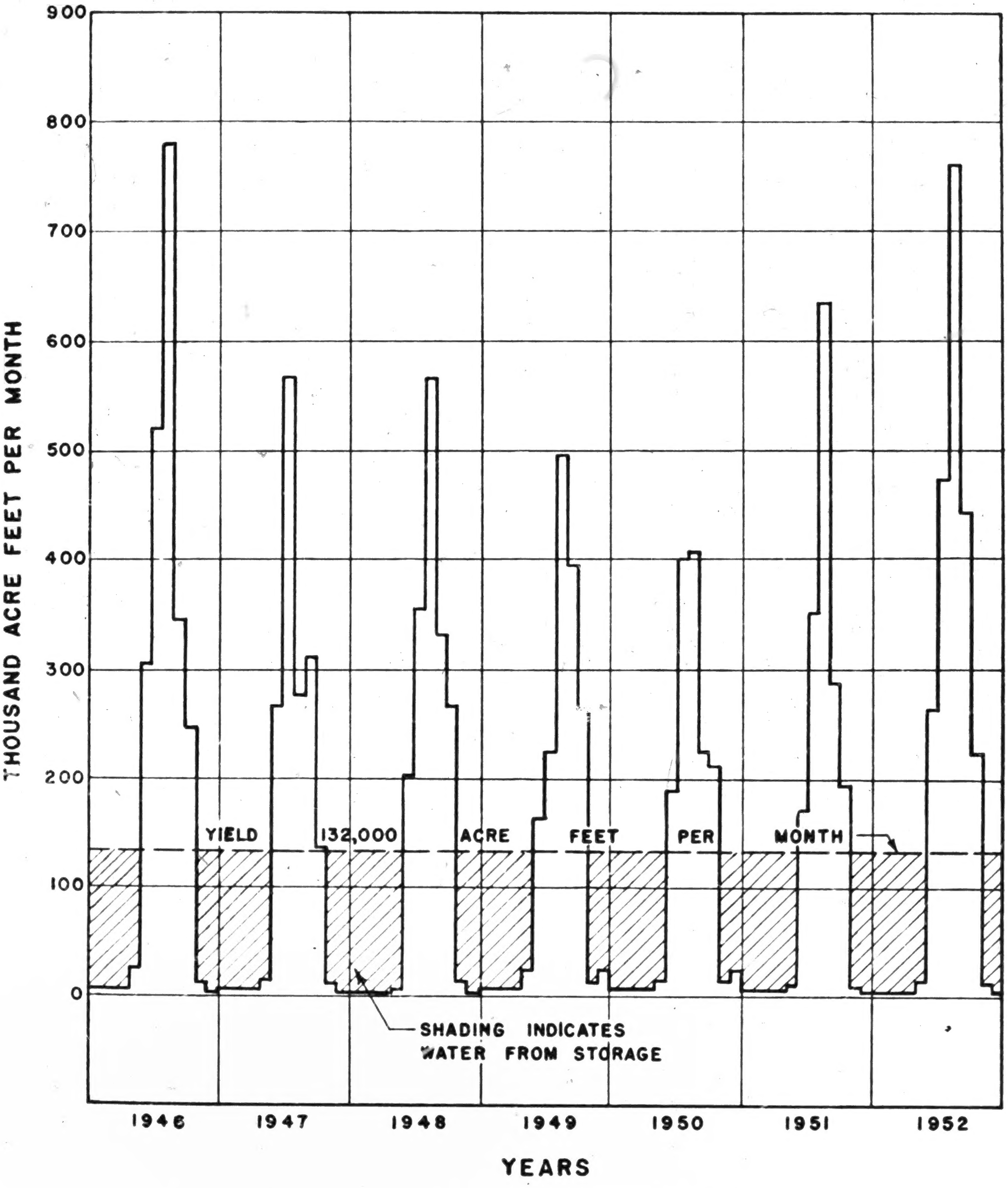
PEGU RIVER AT IRON BRIDGE
PEGU TOWN

STAGE-DISCHARGE CURVE

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR BY. E.J.P. DATE PLATE
CK BY. GMT MAY 53 NO. 8



MINISTRY OF NATIONAL PLANNING

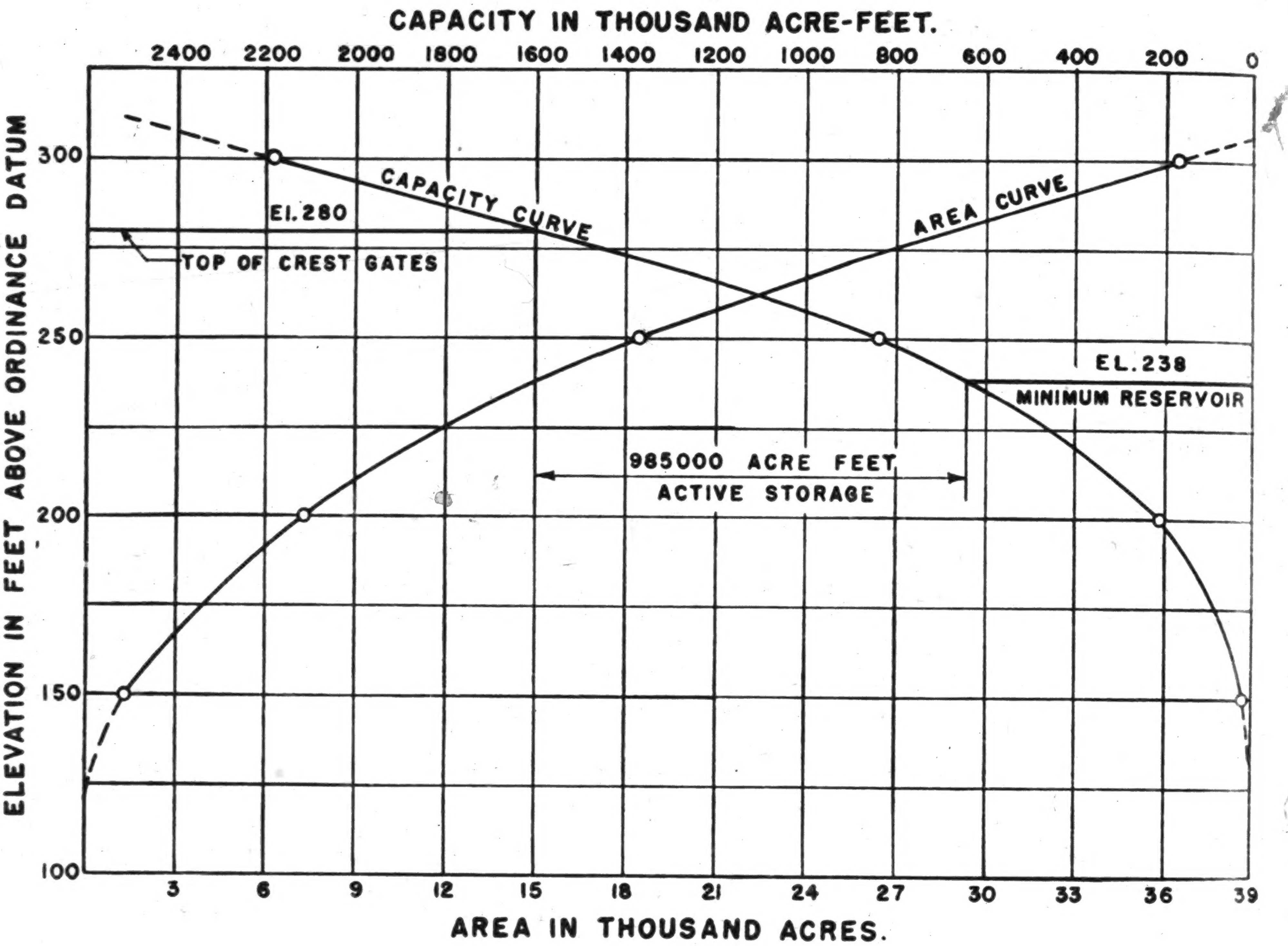
PEGU RIVER HYDRO PROJECT

HYDROGRAPH OF MONTHLY RUNOFF

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR BY. E.J.P. DATE PLATE
CK BY. GMT MAY, 53. NO. 9.

R.B. II—7



ELEVATION	AREA IN ACRES	RESERVOIR CAPACITY IN A/F.
120' T.W.L.	NIL †	NIL
150' CONTOUR	1,363·2	13,630
200' CONTOUR	7,334·4	211,280
250' CONTOUR	18,521·6	836,460
300' CONTOUR	36,400·0	2,184·560

† ASSUMED AS ZERO

MINISTRY OF NATIONAL PLANNING

PEGU HYDRO-ELECTRIC PROJECT

RESERVOIR
AREA-CAPACITY CURVE.

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. E.J.P. DATE PLATE
CK. BY. G.M.T. MAY 53. NO. 10

TABLE XIX - 13

PEGU RIVER HYDROELECTRIC PROJECT

Cusecs, Continuous Output from Reservoir, 1946—1952

	*Thousand Acre Feet per Month**						*Cusecs Continuous Output*
	Inflow†	*Make up from Storage*	*Depletion of Reservoir*	*Gross Yield*	*Evaporation*	*Net Yield (usable)*	
1946							
Jan.-Apr.	27	503	503	530	29	501	
May	28	104	607	132	5	127	
June	305	−173	434	132	0	132	
July	519	−387	47	132	0	132	
Aug.	783	− 47	0	736	0	132	
Sept.	343	—	—	343	0	132	
Oct.	247	—	—	247	0	132	
Nov.	13	119	119	132	8	124	
Dec.	3	129	248	132	8	124	
	2,268					1,536	2,100
1947							
Jan.-Apr.	27	503	751	530	21	509	
May	14	118	869	132	4	128	
June	268	−136	733	132	0	132	
July	567	−435	298	132	0	132	
Aug.	277	−145	153	132	0	132	
Sept.	312	−153	0	159	0	132	
Oct.	138	—	—	138	0	132	
Nov.	13	119	119	132	8	124	
Dec.	3	12[illegible]	248	132	8	124	
	1,619					1,545	2,120
1948							
Jan.-Apr.	11	519	767	530	21	509	
May	14	118	885	132	4	128	
June	201	− 69	816	132	0	132	
July	355	−223	593	132	0	132	
Aug.	565	−433	160	132	0	132	
Sept.	331	−160	0	171	0	132	
Oct.	268	—	—	268	0	132	
Nov.	13	119	119	132	8	124	
Dec.	3	129	248	132	8	124	
	1,761					1,545	2,120
1949							
Jan.-Apr.	27	503	751	530	21	509	
May	28	104	855	132	4	128	
June	165	− 33	822	132	0	132	
July	227	− 95	727	132	0	132	
Aug.	497	−365	362	132	0	132	
Sept.	395	−263	99	132	0	132	
Oct.	166	− 34	65	132	0	132	
Nov.	13	119	184	132	8	124	
Dec.	28	104	288	132	8	124	
	1,546					1,545	2,120
1950							
Jan.-Apr.	27	503	791	530	21	509	
May	28	104	895	132	4	125	
June	190	− 58	837	132	0	132	
July	400	−268	569	132	0	132	
Aug.	407	−275	294	132	0	132	
Sept.	228	− 96	198	132	0	132	
Oct.	212	− 80	118	132	0	132	
Nov.	13	119	237	132	8	124	
Dec.	28	104	341	132	7	125	
	1,533					1,546	2,120
1951							
Jan.-Apr.	11	519	860	530	20	510	
May	7	125	985	132	3	129	
June	171	− 39	946	132	0	132	
July	352	−220	726	132	0	132	
Aug.	634	−502	224	132	0	132	
Sept.	288	−156	68	132	0	132	
Oct.	196	− 64	4	132	0	132	
Nov.	7	125	129	132	8	124	
Dec.	3	129	258	132	8	124	
	1,669					1,547	2,120
1952							
Jan.-Apr.	11	519	777	530	23	507	
May	14	118	895	132	4	128	
June	265	−133	762	132	0	132	
July	476	−344	418	132	0	132	
Aug.	761	−418	0	343	0	132	
Sept.	444	—	—	444	0	132	
Oct.	223	—	—	223	0	132	
Nov.	13	119	119	132	8	124	
Dec.	3	129	248	132	8	124	
	2,210					1,543	2,120

*Except four-month total used opposite Jan.-April.

†Inflow computed by proportionate drainage areas ffom Pegu Iron Bridge records.

(5) Penstock Size

The normal maximum demand from three units will be 5,130 cusecs based on 45,000 kW ultimate installation, and 132-ft. average net head. For a 22-ft. diameter penstock the maximum velocity would be 13·5 ft. per sec. at average head, or 15·9 ft. per sec. at extreme low water for the 112 ft. minimum net head and 6,040 cusecs maximum demand. If a fourth unit should be installed the velocities would be increased 33% to 18.0 and 21·2 ft. per sec. respectively. It is concluded that the 22-ft. diameter penstock is a conservative selection based on present estimates of the size and type of market. It is in accordance with economic standards of design for short penstocks which require 15 to 20 ft. per sec. velocity under the conditions of normal head and output.

(6) Diversion Tunnel

For the seven years record at Pegu Iron Bridge the largest daily discharge was 39,215 cusecs on August 24, 1946, and frequent flows of 30,000 or more occurred each year except 1950. At the dam site, with a drainage area less than half that at the iron bridge, it is probable that construction floods will not exceed 25,000 cusecs during wet years. This amount has been used as a basis for determining the capacity of the diversion tunnel. For a 27-ft. diameter concrete-lined tunnel with a velocity of 40 ft. per sec. the diversion capacity would be 23,000 cusecs and with 50-ft. velocity, 28,700 cusecs. These velocities will be dependent on cofferdam pond levels at the time of a possible construction flood during the wet season. Accordingly, construction schedules will provide for completion of the earth dam during the dry season to a point above danger level, so that overtopping due to a rare frequency flood cannot occur.

(7) Earth Dam

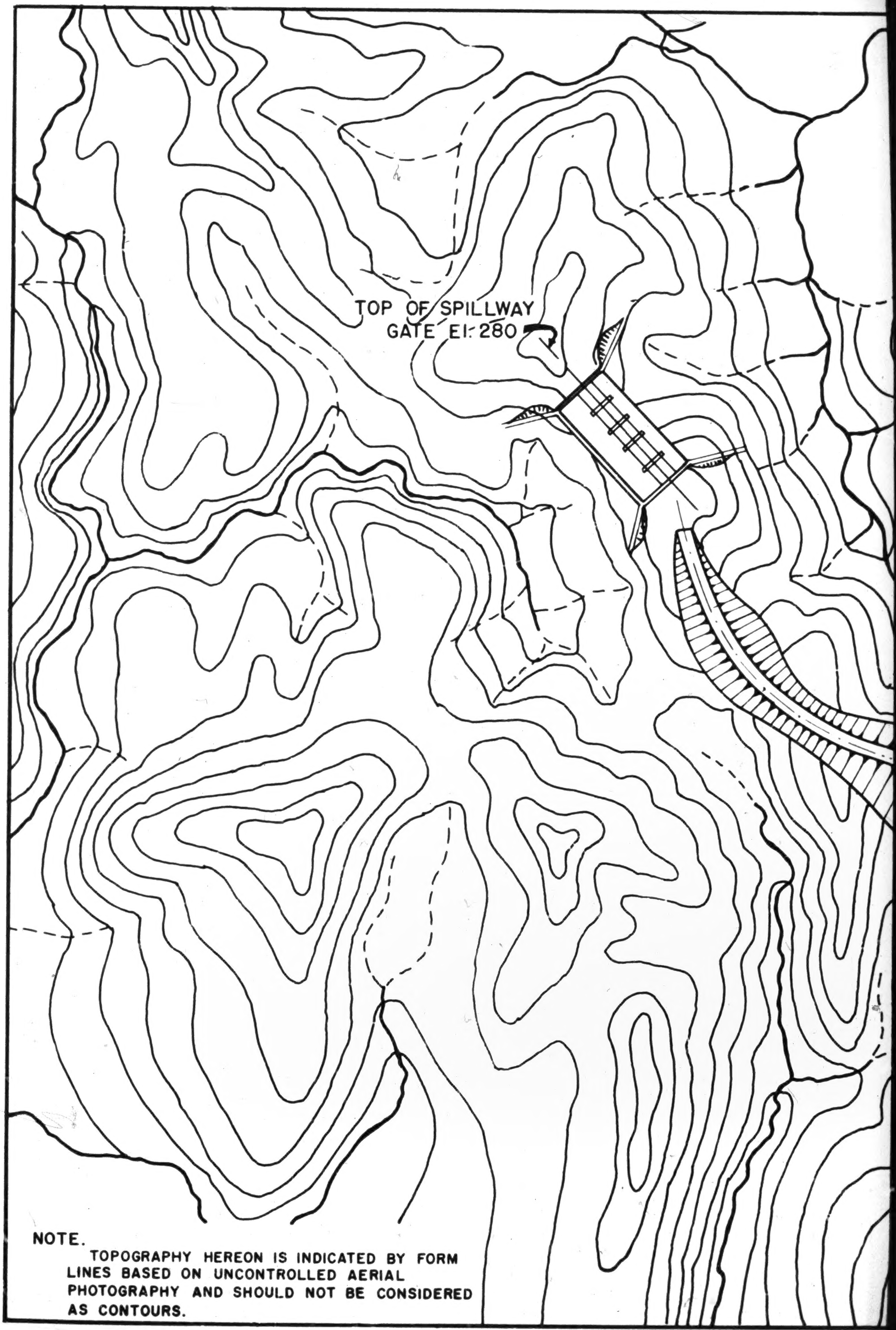
Based on the preliminary reconnaissance and studies it is concluded that the dam site is in a deeply weathered formation covered with moderately heavy overburden. Exposed rock foundations suitable for a concrete dam are not available. Several factors favor the selection of an earth dam, i.e. (*a*) heavy overburden which will provide earth fill material and will support an earth dam without complete excavation to firm rock; (*b*) natural saddle beyond the right abutment for economical spillway construction; (*c*) probable tunnel and power house site in firm rock in the right abutment. It is assumed that the rock from the tunnel and power house excavation will be suitable for slope protection on the earth dam but not sufficiently durable for good concrete aggregates. The dam cross section has been estimated conservatively at one on three upstream and one on two downstream slopes with 30-ft. top width to accommodate an access road. The center portion or core of the dam would be clay silt containing weathered shale from the borrow pit upstream from the right abutment. Broken shale would be used in the transition to provide a filter varying from the finest materials adjacent to the core to larger fragments of hard shale near the outer slopes. The shale would be protected with a heavy layer of sandstone riprap in sizes from 200 to 2,000 lbs. per stone, in order to break waves on the upstream slope, and to control erosion and withstand sun action on the downstream slope. The shale and sandstone would be obtained from the tunnel, power house, tailrace and spillway excavations. If insufficient sound rock is available from these sources, rock may be imported from the quarries at Mokpalin, and the downstream slope may be protected with Bermuda grass or equal. In order to minimize underseepage a cutoff trench would be excavated to bedrock or impervious strata along the axis of the dam. At the bedrock surface a concrete grout cap would be constructed through which drilling and grouting would be accomplished. The cutoff trench would be refilled with rolled impervious earth fill.

(8) Outlet Works

The right abutment location for the outlet works appears to be the most favorable, with a minimum length of tunnel intake and outlet channels (see Plate 11). The tunnel would be located in shale and sandstone requiring considerable bracing with steel or timber rings. It would be lined with reinforced concrete, and grouting would be provided between the concrete and rock over the roof of the tunnel. At the upstream end there would be a concrete intake tower containing trash racks, stop logs, and emergency headgates. Mechanical trash rake and gate hoists would be accessible by steel truss foot bridge from the right abutment. The 22-ft. diameter penstock would be anchored at its upstream end by a concrete tunnel plug and would be supported on concrete saddles throughout its length. At the downstream end three lateral 11-ft. diameter pipes would lead to three turbines in the power house, each protected by an 11-ft. diameter penstock valve. The 22-ft. pipe would be reduced in stages to 11 ft. in passing the laterals and the discharge end would be controlled by two 11-ft. valves in tandem. The tunnel discharge channel would be concrete lined for about 300 ft. below the outlet portal to withstand high velocity flow during its use for river diversion.

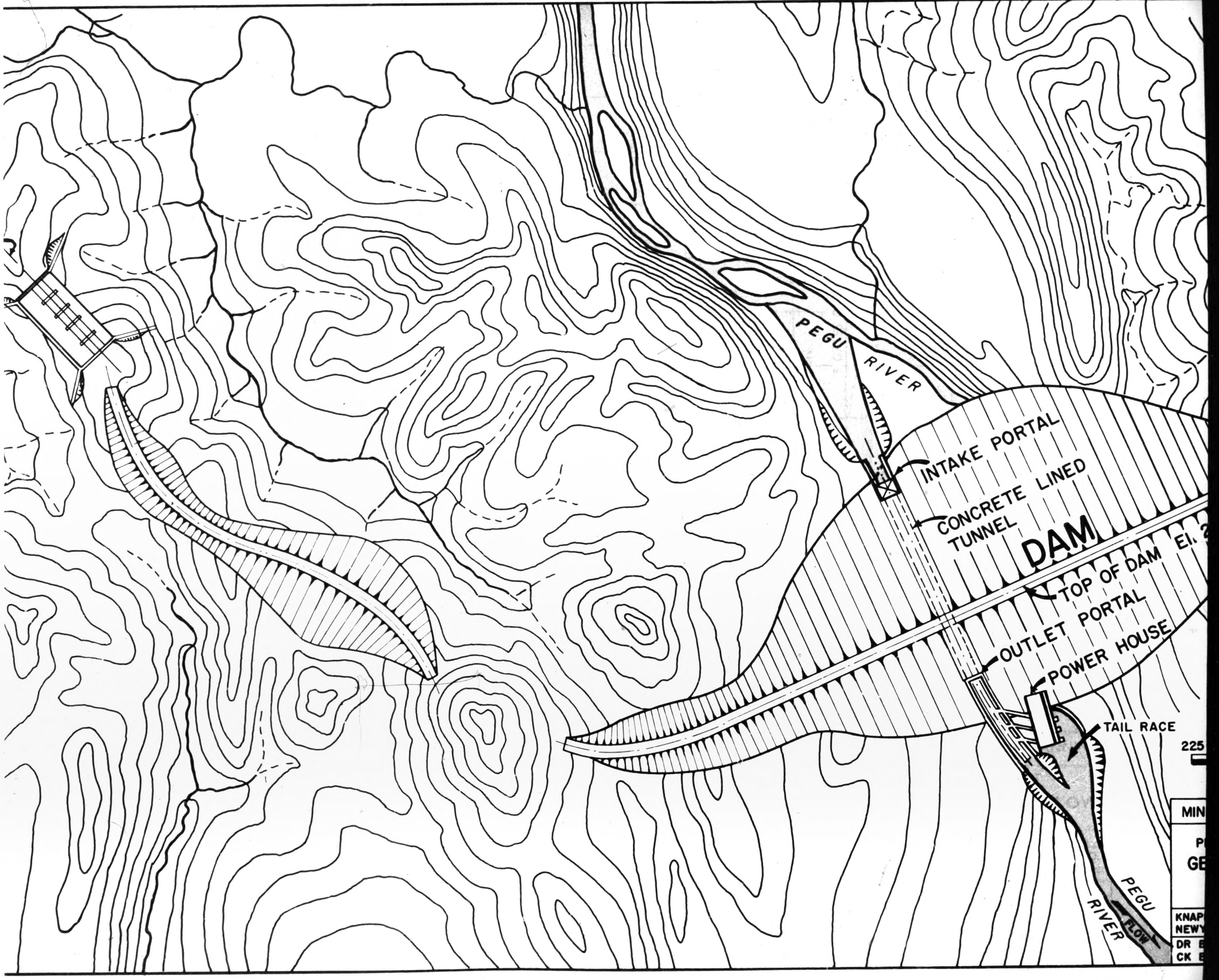
(9) Spillway

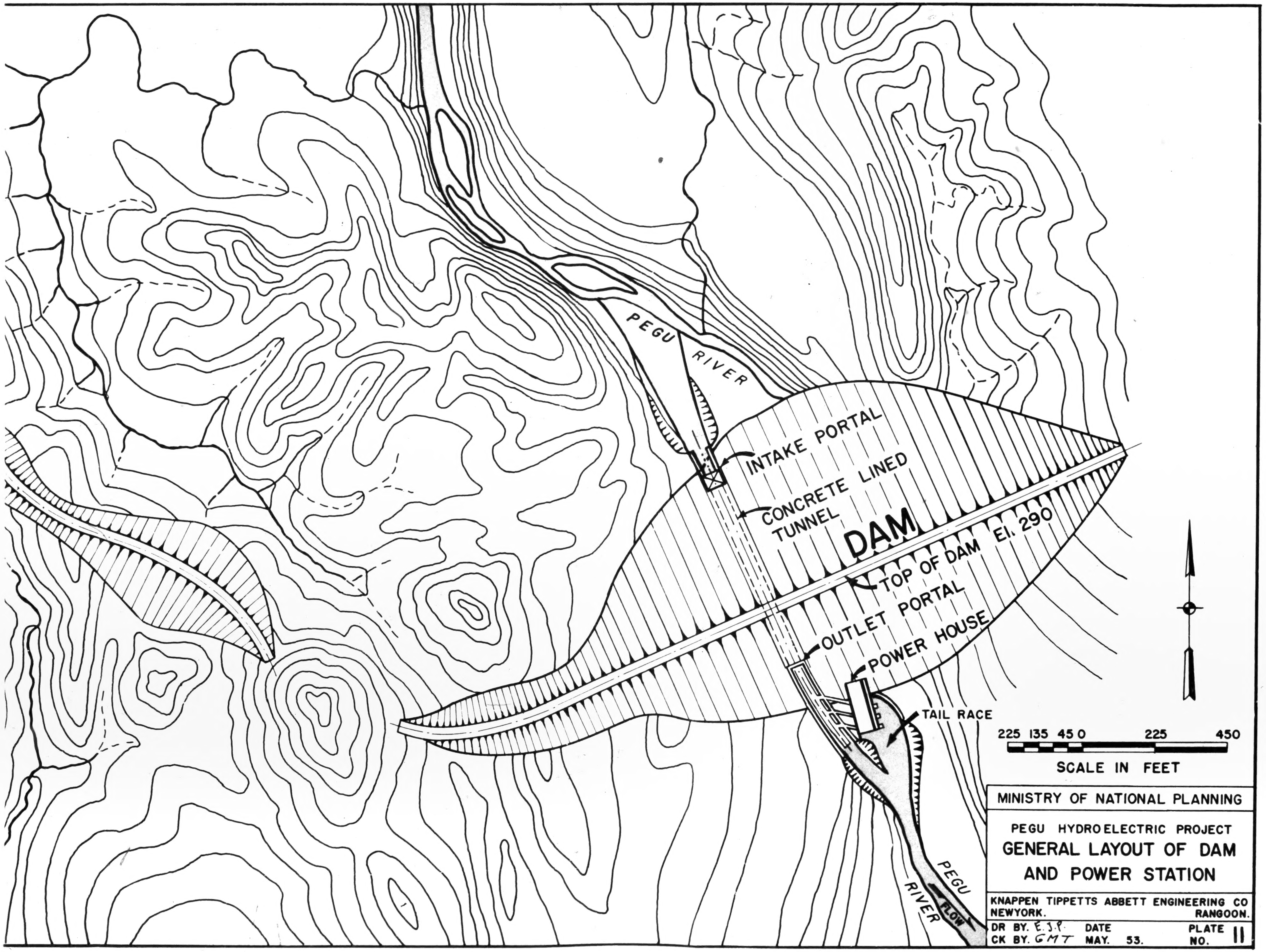
About one half mile west of the dam site there is a natural saddle in which the spillway structure would be located as shown on Plate 11. This would be a concrete ogee section founded on firm rock and surmounted by five Tainter gates each 50 ft. long by 20 ft. high. The length of structure, face to face of training walls, would be about 270 ft. The gates would be provided with individual electric hoists and individual gasoline standby units located at the gate piers. A light foot bridge would connect the piers and abutments for safe access during floods. Below the spillway a concrete apron, baffles and end sill would be provided to dissipate the energy of the flood waters. Derrick stone and riprap would be placed downstream from the end sill. An analysis has been made of several hypothetical floods showing the effect of surcharge storage in each case (see Plate 12 and 13, "Flood Hydrographs" and "Mass Curves of Reservoir Inflow and Outflow"). For the flood equal to


TOP OF SPILLWAY
GATE El. 280

NOTE.

TOPOGRAPHY HEREON IS INDICATED BY FORM LINES BASED ON UNCONTROLLED AERIAL PHOTOGRAPHY AND SHOULD NOT BE CONSIDERED AS CONTOURS.


PEGU RIVER
INTAKE PORTAL
CONCRETE LINED TUNNEL
DAM
TOP OF DAM El. 2
OUTLET PORTAL
POWER HOUSE
TAIL RACE
225
PEGU RIVER
FLOW
MIN
P
GE
KNAP
NEWY
DR E
CK E


PEGU RIVER
INTAKE PORTAL
CONCRETE LINED TUNNEL
DAM
TOP OF DAM El. 290
OUTLET PORTAL
POWER HOUSE
TAIL RACE
225 135 45 0 225 450
SCALE IN FEET
PEGU RIVER
FLOW

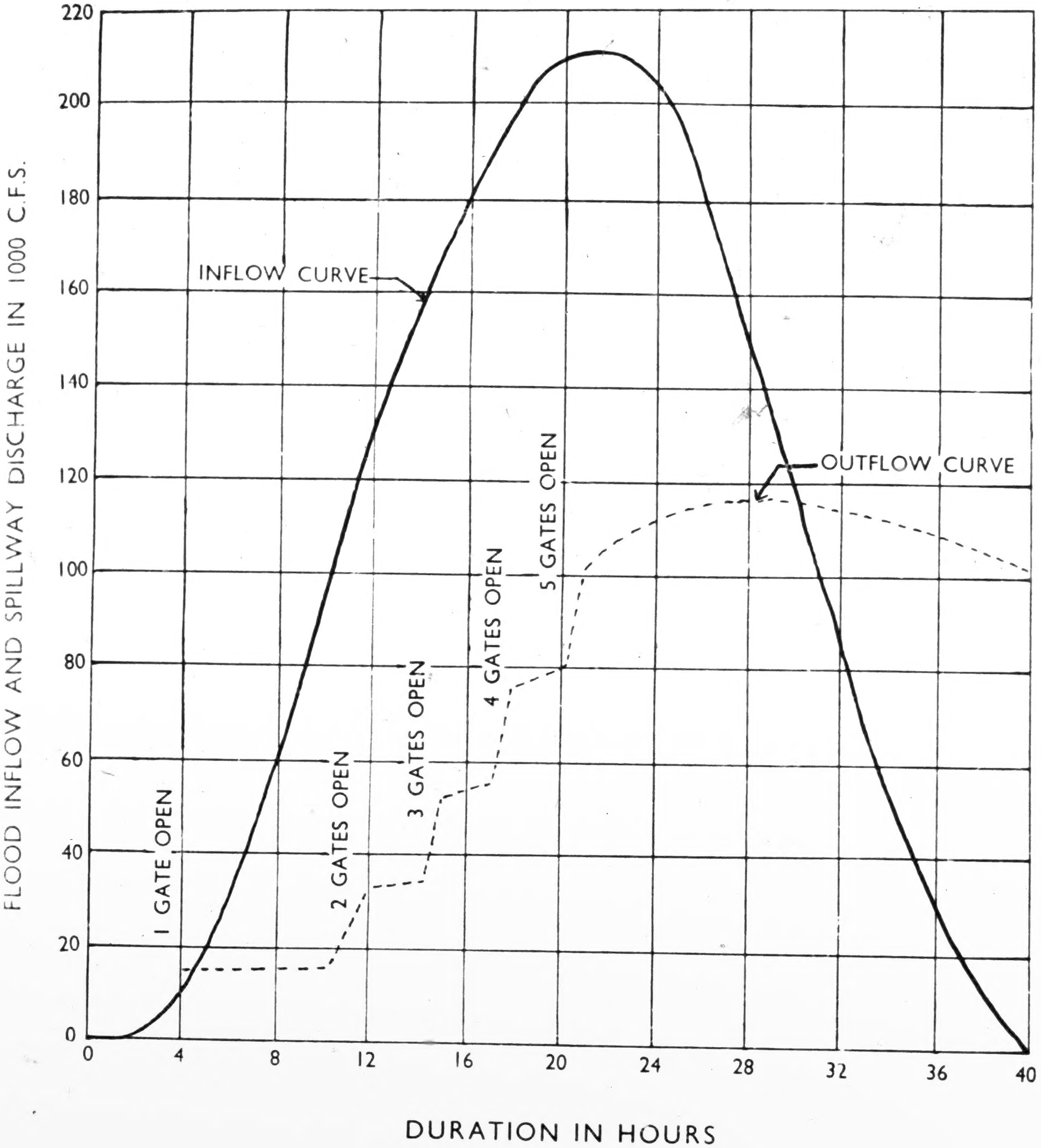
MINISTRY OF NATIONAL PLANNING

PEGU HYDRO ELECTRIC PROJECT

GENERAL LAYOUT OF DAM AND POWER STATION

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEWYORK. RANGOON.

DR BY. E.J.P. DATE PLATE
CK BY. GMT MAY. 53. NO. 11



HYDROGRAPH BASED ON PEAK INFLOW. QM$=10,000\sqrt{A}=210,000$ CUSECS, VOLUME OF RUNOFF EQUIVALENT TO 15 INCHES OF RAINFALL, i.e. $15,300\times10^6$ CU. FT. OR 352,000 ACRE-FT. AND DURATION OF FLOOD 40 HOURS

MINISTRY OF NATIONAL PLANNING

PEGU RIVER PROJECT

FLOOD INFLOW-OUTFLOW HYDROGRAPHS

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY *E. J. P.* DATE PLATE
CK. BY *G. M. T.* MAY 53 NO. **12**

10,000 times the square root of the drainage area, there would be six feet of freeboard at maximum reservoir level, assuming all turbines and sluice valves closed throughout the flood and crest gates to be opened at increments of one foot in the reservoir water level starting at El. 278. About 52 hours would be required to empty the surcharge volume assuming crest gates to be closed at one foot increments of reservoir level. The spillway outlet has a favorable location about 1½ miles downstream from the power house and tailrace.

(10) Power House

Two 21,000-horsepower-at-normal-head vertical Francis turbines directly connected to 15,000 kW water wheel generators would be provided initially. The power house substructure, founded on rock near the tunnel outlet portal, would include the draft tube for a third unit of 15,000 kW; and in future could be extended to accommodate a fourth unit on line with the others supplied by a penstock from the 11-ft. sluice valve. The power house is set at an angle with the center line of the outlet works, to improve hydraulic efficiency at the entrance to the scroll case and to permit construction of the power house during the diversion period. There would be a steel frame superstructure with brick walls and tile roof utilizing local materials and labor for this feature. An outdoor installation is not considered feasible in view of the heavy rains which sometimes reach as much as 40 inches per month.

(11) Substation

An outdoor substation would be provided with the main transformers located at the power house and with switching structure on the downstream berm of the earth dam, east of the outlet channel. The initial capacity would be 30,000 kW with a layout to permit the addition of 15,000 kW in the near future and possibly another 15,000 kW in the future. Voltage would be stepped up from 13·8 kV to 132 kV at the transformer bank. A double circuit 60,000 kW line would lead southward, one circuit to supply Pegu, Syriam and Rangoon, and the other circuit to supply Tharrawaddy, Henzada and Rangoon.

(12) Transmission Line

Initial lines would consist of 132 kV 60,000 kW double circuit from the power station to a junction five miles south as shown on Plate 2. From the junction, one 30,000-kW single circuit line would supply Pegu and Rangoon, with a 10,000-kW branch to Syriam; and one 30,000-kW single circuit line would supply Tharrawaddy and Rangoon with a 10,000-kW branch to Letpadan and Henzada. The Pegu to Rangoon line would be designed to take a second circuit so that power from the proposed Paunglaung hydroelectric development may be brought in on that circuit. All lines would be adjacent to existing highways and railroads through generally flat rice lands with no clearing required, except from the dam to Zaungtu and from the junction to Tharrawaddy. These portions are in rolling, jungle-covered terrain without access roads.

(13) Distribution System

A sizable distribution system exists in the Rangoon-Insein area and is being expanded at the rate of 5,000 connections per year by the Rangoon Electric Tramway and Supply Co. The development of this system should remain under the control of RET, an efficient organization which should not be replaced by Government management if it can be avoided. Details of the proposed distribution system at Pegu, Henzada, Letpadan, Tharrawaddy and Taikkyi need not be determined until additional data are available. The development should be under the close control of a private management firm, in order that the sale of energy and appliances can be rapidly expanded. This will assure maximum profit to the Government from the power development and sufficient reward to the private owner so that he will energetically promote sales. The franchise to sell power at rates approved by the Government should be awarded to the highest qualified bidder. Financing for major installations should be accomplished by low interest loans to the private owner. The foregoing procedure is believed to be the best means of expanding the new power system rapidly and of giving efficient personal service to the consumer.

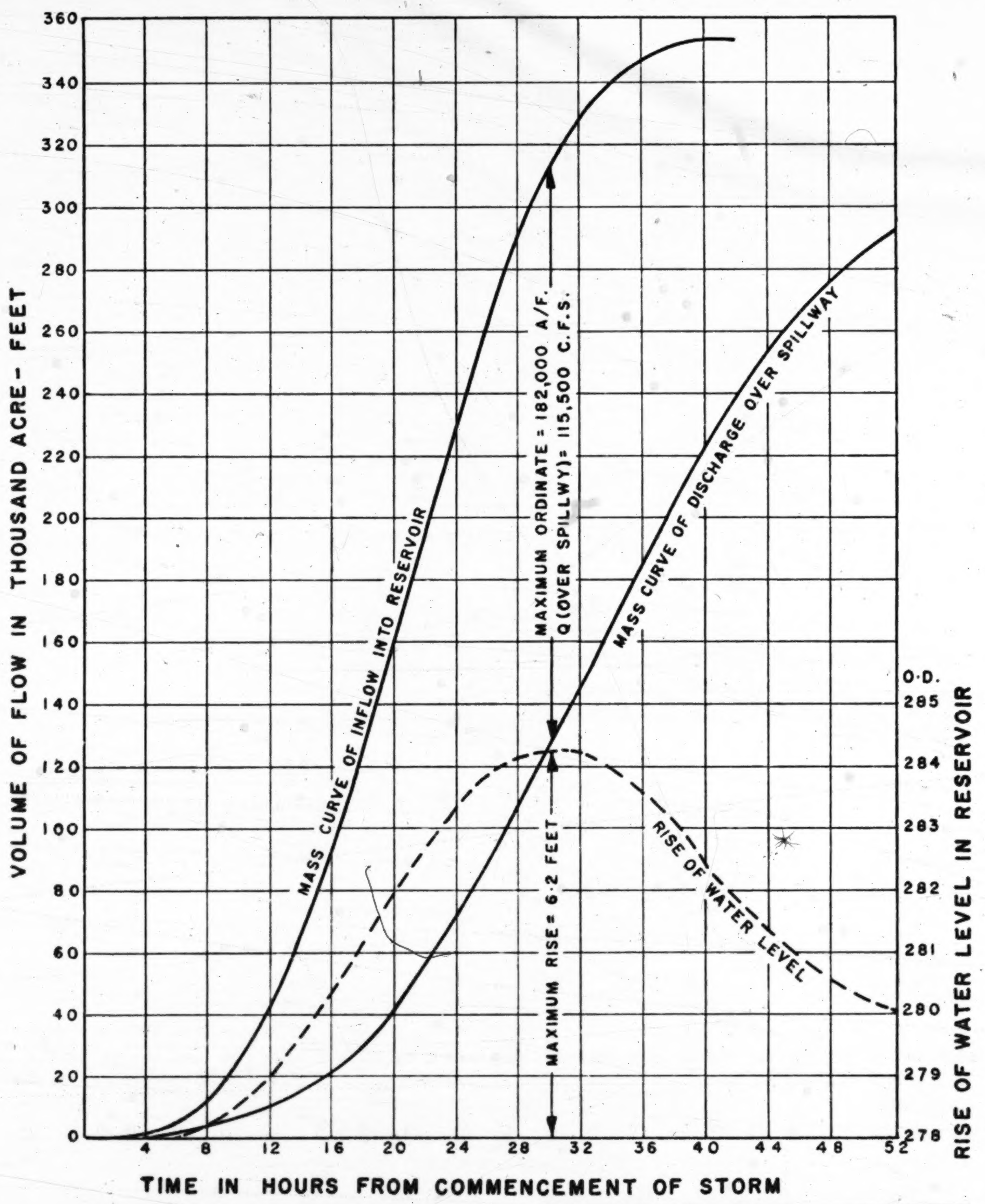
m. Construction Materials and Equipment

(1) Earth Fill

It is probable that the borrow area for the earth dam can be located just upstream from the right abutment. It is believed that the area contains ample quantities of clay silt with fragments of weathered shale suitable for rolling into the impervious portion of an earth dam. The length of haul will vary from 1,000 to 2,000 ft.

(2) Gravel and Broken Stone

Pervious material to form the shells or filter portions of the earth dam can be obtained from two sources: (*a*) rounded gravel from branch streams in very limited quantities, and (*b*) shale outcrops in both abutments upstream or downstream from the dam. The latter should be the principal source of pervious material because the quantity available is large and the shale is believed to be resistant to disintegration if protected from drying. It should be mixed with



CURVES SHOWING RELATION BETWEEN
STORM WATER INFLOW INTO RESERVOIR,
DISCHARGE OVER SPILLWAY AT CREST
LEVEL 260·00 O.D. WITH GATE
OPENINGS AS BELOW, AND RISE
OF FLOOD WATER.

W.S.L. AT 1ST. GATE OPENING = 278·00 O.D
" " 2ND. " " = 279·00 O.D.
" " 3RD. " " = 280·00 O.D.
" " 4TH. " " = 281·00 O.D.
" " 5TH. " " = 282·00 O.D.

ALL GATES CLOSED AT W.S.L. 280·00 O.D.
ON FALLING FLOOD.

MINISTRY OF NATIONAL PLANNING

PEGU RIVER PROJECT

MASS CURVE

RESERVOIR INFLOW - OUTFLOW

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. E.J.P. DATE PLATE
CK. BY. GMT MAY, 53. NO. **13**

sandstone fragments and the largest, most stable stone should be used nearest the surface directly under the slope protection stone. These features will be subject to review when samples have been obtained from the site and tests have been completed.

(3) Slope Protection Stone

It is probable that suitable stone will be obtained from the tunnel, powerhouse and tailrace excavation for use on the slopes of the dam and for riprap areas where wave action or turbulent flow must be resisted. Additional stone may be obtained from the existing granite quarries at Mokpalin on the east bank of the Sittang River about 60 miles from the dam site.

(4) Concrete Aggregates

Large deposits of suitable gravel for concrete aggregates are reported in the vicinity of Pyinbongyi, about 40 miles from the dam site. The use of this gravel would necessitate the construction of a long access road and overland haul. Possibly the existing granite quarries at Mokpalin will prove more economical, utilizing a 60-mile water haul via the Pegu–Sittang canal in shallow draft barges. It is understood that the governing depth in the Pegu River north of Pegu Town is about four feet during half of the year and during the six dry months complete stoppage of navigation will occur due to lack of water. Mokpalin granite has been used for road surfacing and concrete aggregates throughout Burma with successful results.

(5) Timber, Brick and Tile

Timber for operators' houses, concrete forms and other temporary construction can be obtained in the Pegu Valley. Where smooth surfaces must be obtained absorptive form lining should be imported. Such surfaces include tunnel lining, intake and outlet walls, powerhouse draft tube and tailrace walls, and spillway training walls, piers, baffles and end sills. Brick and tile for the powerhouse superstructure and other permanent buildings can be procured in Burma. The manufacture of tile will be initiated in the near future under Government sponsorship.

(6) Plumbing and Electric Fixtures

Small pipe, valves, fittings and fixtures can be purchased from the countries in the "soft currency" area through existing supply houses subject to satisfactory prices and delivery dates. Electrical wire, fittings and fixtures can be obtained from the same source.

(7) Reinforcing Steel, Structural Steel, Penstock, Headgates and Hoists

These may be purchased from the same source subject to satisfactory prices and delivery dates.

(8) Hydraulic and Electrical Machinery and Controls

For the purpose of the present estimates, United States prices have been used. If equal or lower prices and satisfactory delivery time can be secured from the manufacturers in "soft-currency" countries, they should be given consideration.

(9) Powerhouse Crane

Purchase of a 100-ton overhead crane with rails and controls should be made in the "soft currency" area subject to satisfactory price and delivery date.

(10) Substation, Transmission, Distribution Equipment

These should be purchased in a country in the "soft currency" area where manufacturing capacity is known to be ample.

(11) Construction Equipment

(a) Earth moving. Shovels, bulldozers, scrapers, trucks and miscellaneous earth equipment should be supplied by the general contractor in accordance with his estimated needs. For the purpose of computing foreign exchange it is assumed that a foreign contractor will be selected using equipment manufactured in the United States.

(b) Concrete plant. This would probably be supplied from the United States by the general contractor.

(c) Rock excavation equipment. This would also be supplied from the United States by the general contractor.

(d) Steel erection equipment. This would be supplied from a "soft currency" country by the general contractor, particularly if structural steel, gate hoists and powerhouse crane are from this source.

n. Design Contract

In order to complete the Pegu project in 1957, a design contract should be entered into as soon as possible between the Government and an engineering firm experienced in hydroelectric work. The contract should include field investigation and detailed design of dam, power station and transmission lines. Plans and specifications together with the analysis of design should be completed in 12 months but the tunnel design should be accomplished in four months so that its construction can be expedited. The engineering firm should be selected by negotiation and should be paid costs plus a fixed fee in accordance with standards equivalent to those established by the American Society of Civil Engineers.

o. Construction Contract

(1) Type of Contract

In view of the lack in Burma of contractors experienced in hydroelectric construction and in view of the continued activity in heavy construction throughout the world, it is doubted that a lump sum contract can be secured in the customary manner by competitive bidding. However, a "target price" contract should be secured with an experienced contractor in which he contracts to complete the work for a target price (containing a reasonable contingency allowance for his protection) plus a fixed fee subject to the following provisions. If the actual costs are less than the "bid target," he will be paid for the actual costs plus the fixed fee plus 20% of the difference between the actual costs and the "bid target." If the actual costs are greater than the "bid target," he will be paid for actual costs plus his fixed fee less 10% of the difference between actual costs and "bid target." The bid target as used above, will be the original bid target adjusted once at the completion of the contract for changes in wage rates, material prices and work quantities. The target price contract has been used successfully for current projects in the Middle East, West Indies and other areas where the construction industry is not strongly developed and competition cannot be obtained.

(2) Completion on Schedule

The contract should provide that liquidated damages be assessed at approximately K5,000 per day, the estimated profit on the system, in the event that the contractor fails to complete the work in accordance with the construction schedule. In order to give the contractor every opportunity to expedite the work he should be solely responsible for the purchase of all materials and equipment, subject only to inspection by the supervising engineers. The contractor should be permitted to import such construction equipment, skilled labor, foremen and administrative personnel as he deems essential for prompt completion of the work.

p. Construction Engineering

In order to assure the quality of materials and workmanship in accordance with the specifications, supervisory inspection and control of construction should be the responsibility of an engineering firm experienced in hydroelectric and transmission line construction work. The engineering firm should be selected by negotiation and should be paid costs plus a fixed fee in accordance with standards for this type of work in Asian and Pacific projects.

q. Operation and Maintenance Contract

For a period of at least five years after completion of the construction, the dam, power station and transmission line should be operated and maintained by contract. The contractor should be selected by negotiation. He should furnish a superintendent, operators and skilled labor as needed for routine or major repairs. He should furnish the necessary tools and equipment. He should have full authority to employ foreign assistants or experts, subject to the financial limitation of his contract. During the life of the contract, apprentice superintendents, operators and skilled labor should be hired locally, so that Burmese nationals can receive necessary training in order to hold key operating jobs as soon as possible.

r. Estimated Costs

Quantity and cost estimates are based on very incomplete data including aerial photographs of the site and stream flow measurements (1946–1952) at Pegu Town, 50 miles downstream from the dam site (see Table XIX–14 (*p. 598*)—"Estimated Cost—Initial Installation"). Excavation, concrete and steel prices are based on costs of similar work recently completed in Burma. Hydraulic machinery, electrical machinery and penstock valves are estimated from preliminary quotation by American manufacturers. A contingency and engineering factor of 20% has been allowed in addition to a fee of approximately 4% for the detailed exploration and design. No details for the distribution system have been developed, but the kWh charges are assumed to be slightly greater than the present costs for the Rangoon metropolitan area, in view of the more scattered communities. The annual charges capitalized at 12% give the total estimated cost of the distribution system as presented in Table XIX–14. The over-all costs of hydro station, transmission line and distribution system are conservative in comparison with the actual cost of similar projects completed recently in other countries.

s. Production Costs

The cost of power at the load center is computed as follows:

Capital recovery with interest at 4.25%

Description	*Life in Years*	*Factor*	*Investment* $	*Annual Cost* $
Elect. Controls	20	·0752	120,000	9,000
Generators, Portion of Substation	25	·0655	1,520,000	99,600
Turbines, Butterfly Valves, Trash Racks	35	·0555	1,460,000	81,000
Transmission Line	35	·0555	2,570,000	142,500
Civil Eng. Works Buildings	50	·0491	11,440,000	562,000
Operation and Maintenance	—	·0127	17,110,000	217,900
Annual Cost, Initial Development (6·5%)				$1,112,000

Note: Interest has been assumed at 4% for 75% of the total investment and 5% for the remainder.

TABLE XIX - 14

PEGU RIVER HYDROELECTRIC PROJECT

ESTIMATED COST—INITIAL INSTALLATION

(U.S. Dollars)

No.	*Description*	*Quantity*	*Unit*	*Unit Cost*	*Cost*	*Percentage*		
						Local	*Sterling*	*U.S.*
				$	$			
1	Exploration and design	l.s.	—	—	700,000	20	—	80
2	Clearing reservoir	10,000	acre	50.00	500,000	80	10	10
3	Clear and grub dam site	60,000	s.y.	1.00	60,000	80	10	10
4	„ „ „ borrow area	80,000	s.y.	0.50	40,000	80	10	10
5	„ „ „ spillway	10,000	s.y.	1.00	10,000	80	10	10
6	„ „ „ townsite	30,000	s.y.	0.50	15,000	80	10	10
7	Access roads	4	mi.	10,000	40,000	70	20	10
8	Excavation, cutoff trench	8,000	c.y.	4.00	32,000	70	10	20
9	„ tunnel portals	30,000	c.y.	3.00	90,000	70	10	20
10	„ tailrace	80,000	c.y.	3.00	240,000	70	10	20
11	Excavation, power house	46,000	c.y.	5.00	230,000	70	10	20
12	„ spillway	100,000	c.y.	1.00	100,000	70	—	30
13	„ borrow pit	3,500,000	c.y.	0.52	1,820,000	70	—	30
14	Cofferdam and diversion	l.s.	—	—	250,000	70	—	30
15	Foundation preparation, dam	40,000	s.y.	1.50	60,000	70	—	30
16	Drilling holes for grout	60,000	l.f.	1.00	60,000	60	—	40
17	Grouting cutoff and tunnel	120,000	c.f.	2.00	240,000	60	—	40
18	Placing and rolling earth fill	3,200,000	c.y.	0.15	480,000	60	—	40
19	Excavation, tunnel	21,000	c.y.	10.00	210,000	60	—	40
20	Concrete, tunnel lining	7,350	c.y.	60.00	440,000	60	—	40
21	Concrete, portals and channel	10,000	c.y.	32.00	320,000	60	—	40
22	„ intake tower	10,500	c.y.	40.00	420,000	60	—	40
23	„ spillway	18,000	c.y.	32.00	576,000	60	—	40
24	„ power house substruct.	9,000	c.y.	48.00	432,000	50	—	50
25	„ retaining wall	2,000	c.y.	40.00	80,000	60	—	40
26	Reinforcing steel	3,000,000	lbs.	0.10	300,000	40	50	10
27	Penstock steel	2,400,000	lbs.	0.25	600,000	40	50	10
28	Trash racks and frames	500,000	lbs.	0.25	125,000	40	50	10
29	Head gates, frames, hoists	400,000	lbs.	0.50	200,000	40	50	10
30	Gate house and bridge	l.s.	—	—	40,000	50	40	10
31	Spillway gates, 5 @ 50×20	500,000	lbs.	0.30	150,000	40	50	10
32	„ „ hoists	5	each	4,000	20,000	40	50	10
33	Hydraulic machinery	42,000	h.p.	22.00	924,000	20	—	80
34	Electrical machinery	30,000	kW	38.00	1,140,000	20	—	80
35	Additional butterfly valves	2	each	50,000	100,000	20	—	80
36	Electrical controls	l.s.	—	—	100,000	20	—	80
37	Substation complete	l.s.	—	—	250,000	20	—	80
38	Power house superstructure	300,000	c.f.	1.00	300,000	60	30	10
39	Crane complete	l.s.	—	—	100,000	20	60	20
40	Living quarters	l.s.	—	—	300,000	40	50	10
41	Transmission line	5	mi.	15,000	75,000	50	30	20
42	„ „	168	mi.	10,000	1,680,000	50	30	20
43	„ „	34	mi.	8,000	272,000	50	30	20
44	„ „	19	mi.	6,000	114,000	50	30	20
	Subtotal				14,235,000			
45	Engineering and contingencies	20%			2,875,000			
	Total hydro plant and trans. system				17,110,000	49·0	12·6	38·4
46	Distribution system*				8,600,000	50	30	20
	Total				25,710,000	49·3	18·4	32·3

* Exclusive of Rangoon 1952 system and initial diesel program.

Initial Development	*Cost per kWh at Load Center* kWh	*Mills*	*Pyas*
Total Power (Par. 1(4))	118,000,000	9·44	4·48
75% Sales	88,500,000	12·60	6·00

Ultimate Development ·065 × 21,610,000 = $1,405,000

Ultimate Development	*Cost per kWh at Load Center* kWh	*Mills*	*Pyas*
Total Power (Par. 1(4))	139,000,000	10·10	4·80
75% Sales	104,000,000	13·50	6·43

The foregoing cost comparison is based on firm power computed for the minimum years of record and on capacity factors which can be attained with the installation of the steel mill, irrigation pumps or equivalent industrial loads as detailed in Tables XIX–8 to XIX–11 inclusive. Secondary power is not large and has been neglected in the economic analysis presented above. The value of power for design of pipe line, tailrace and other hydraulic features should be taken at 4·5 pyas per kWh.

t. Distribution Costs

Details of the proposed distribution system cannot be foreseen but it is believed that 7·5 pyas (1·57 cents) per kWh is an ample allowance for a new system containing about 25% domestic load as given in Tables XIX–5 and XIX–6 for 1958. The allowance has been reduced to 7·0 pyas for 1962 and 6·5 pyas for 1966, when loads are greater and system inefficiencies have been reduced. The annual cost for 1958 to 1966 and the initial investment are computed as follows:

Domestic and Bulk Sales	*kWh per year*		*Pyas*	*Annual Cost in Kyats*
1958	92,000,000	@	7·5	6,900,000
1962	143,000,000	@	7·0	10,000,000
1966	193,000,000	@	6·5	12,530,000

Capitalized at 12%

Year	*Investment in Kyats*	*Investment in Dollars*
1958	57,500,000*	12,100,000
1962	83,300,000	17,500,000
1966	104,300,000	22,000,000

*Of this sum K16,700,000 or $3,500,000 will be provided under the initial diesel program for Pegu, Tharrawaddy and Henzada distribution systems.

Capitalization for the distribution system has been based on capital recovery with interest at 4·25%.

Amortization factor—20 year life	·075
Operation and maintenance	·045
Total annual cost	·120

u. Electric Rates

The proposed domestic electric rates as given in Tables XIX–15 and XIX–16 (*see pp. 600 & 601*) range from 40 pyas per kWh for outlying towns and villages to 30 pyas per kWh for Rangoon–Insein metropolitan area in 1958. It is estimated that these rates can be reduced to 30 and 22 pyas respectively by 1966. The present rates are 75 pyas for outlying towns and 50 pyas for Rangoon. All purpose power, power, bulk power and the steel mill would receive rates of 20, 15, 14 and 10 respectively in 1958 and 16, 12, 10 and 8 respectively in 1966. A Government Rate Board should establish rates for the market area based on the recommendations of the Electricity Supply Board and the managers of the distribution systems.

v. Ownership and Operation

The Government of Burma should own and operate the hydroelectric plant and transmission system. It is understood that the Electricity Supply Board will be the government agency which will control all engineering, construction and operating contracts. The distribution system should be owned and operated by a private management firm financed by low interest government loans for all major installations. It is believed that the sale of energy and appliances can be most successfully expanded by private initiative, assuring larger profits to the Government and incentive income to the private owner. The franchise to operate the distribution system should be awarded to the highest qualified bidder.

w. Recommendations

In view of the favorable factors indicated in this Report, i.e., satisfactory physical conditions for generation of low cost power and ample projected markets in a prosperous region able to absorb the output, it is recommended that the preliminary investigations and design proceed at once. If conditions are found satisfactory, detailed design and construction should be expedited, in order to meet the estimated demands of the market area at the end of 1957.

2. MYINGYAN–MANDALAY POWER PROJECT

a. General

The Government's objective is to supply low cost power as soon as possible to the Myingyan–Meiktila–Mandalay area. In the latter city a power shortage exists which has been partially met by reconditioned steam units installed in 1952. At Meiktila a large army headquarters is under construction and partially occupied. Also this is the center of an important irrigated area where pumping loads are anticipated. Southeast of Meiktila power will be delivered to the proposed Yamethin irrigation development, which is described in Chapter IX on Irrigation. In the Myingyan area the heavy industry planned includes zinc reduction, sulphuric acid production and possibly a fertilizer plant. The most economical source of power in the near future is a steam electric plant located near Myingyan. The plant would use low cost coal transported to the steam plant by barge on the

TABLE XIX - 15

ESTIMATED INCOME AND COST OF ENERGY—1952 to 1966 incl.

(Including Steel Mill, Pegu, Henzada and Irrigation Pumping)

	1952			*1958*			*1962*			*1966*		
Steam Capacity Hydro Capacity	25,000 kW —			35,000 kW 30,000 kW			35,000 kW 85,000 kW			35,000 kW 140,000 kW		
Annual Revenue	*Sales in Thous. kWh*	*Est. Rate Pyas per kWh*	*Annual Revenue Thous. Kyats*	*Sales in Thous. kWh*	*Est. Rate Pyas per kWh*	*Annual Revenue Thous. Kyats*	*Sales in Thous. kWh*	*Est. Rate Pyas per kWh*	*Annual Revenue Thous. Kyats*	*Sales in Thous. kWh*	*Est. Rate Pyas per kWh*	*Annual Revenue Thous. Kyats*
Bulk Power, Rangoon	11,000	16·0	1,760	29,000	14·0	4,060	39,900	12·0	4,790	50,800	10·0	5,080
Steel Mill, Rangoon	—	—	—	27,500	10·0	2,750	37,000	9·0	3,330	46,500	8·0	3,720
All Purpose Power, Rangoon	7,400	28·4	2,100	10,800	20·0	2,160	13,500	18·0	2,430	16,200	16·0	2,590
Power, Rangoon	5,200	25·0	1,300	6,600	15·0	990	8,000	15·0	1,200	9,400	12·0	1,130
Departmental, Rangoon	250	18·75	50	800	15·0	120	1,200	15·0	180	1,600	12·0	190
Public Lighting, Rangoon	900	0	0	4,200	0	0	6,000	0	0	7,800	0	0
Lighting, Rangoon	12,250	55·8	6,840	31,600	30·0	9,480	45,400	25·0	11,350	59,200	22·0	13,020
„ Other	1,000	75·0	750	3,900	40·0	1,560	5,400	35·0	1,890	6,900	30·0	2,070
Bulk Outside Rangoon	—	—	—	2,600	15·0	390	3,600	12·0	430	4,600	10·0	460
Irrigation Pumping	—	—	—	13,000	20·0	2,600	21,000	18·0	3,780	29,000	16·0	4,640
Total Sales	38,000		12,800	130,000		24,110	181,000		29,380	232,000		32,900
Annual Operating Costs	*Output in Thous. kWh*	*Cost in Pyas per kWh*	*Annual Cost Thous. Kyats*	*Output in Thous. kWh*	*Cost in Pyas per kWh*	*Annual Cost Thous. Kyats*	*Output in Thous. kWh*	*Cost in Pyas per kWh*	*Annual Cost Thous. Kyats*	*Output in Thous. kWh*	*Cost in Pyas per kWh*	*Annual Cost Thous. Kyats*
Steam Plant	43,500	14·35	6,250	31,500	14·40	4,550	29,000	14·00	4,060	30,000	13·00	3,900
Exist. Dist. System	43,500	5·75	2,500	43,500	5·75	2,500	43,500	5·75	2,500	43,500	5·75	2,500
Pegu Hydro Plant	—	—	—	118,000	4·48	5,290	139,000	4·80	6,680	139,000	4·80	6,680
Paunglaung Hydro Plant	—	—	—	—	—	—	40,000	4·00	1,600	98,000	4·00	3,900
New Dist. System	—	—	—	106,000	6·50	6,900	164,500	6·08	10,000	223,500	5·61	12,530
Total Cost	43,500	20·10	8,750	149,500		19,240	208,000		24,840	267,000		29,510
Net Profit			4,050			4,870			4,540			3,390

Chindwin and Irrawaddy Rivers from the proposed Kalewa mine. Power would be moderate low cost; Burmese coal would be used; and proposed heavy industrial loads would be located adjacent to the power plant. Mandalay and Meiktila are tied in by short transmission lines in order to guarantee sizable loads quickly after completion of the project. It is estimated that the selected capacity of 30,000 kW will meet the demand until about 1960 at which time low cost hydroelectric power should be available from the future Paunglaung River project near Pyinmana.

b. Location

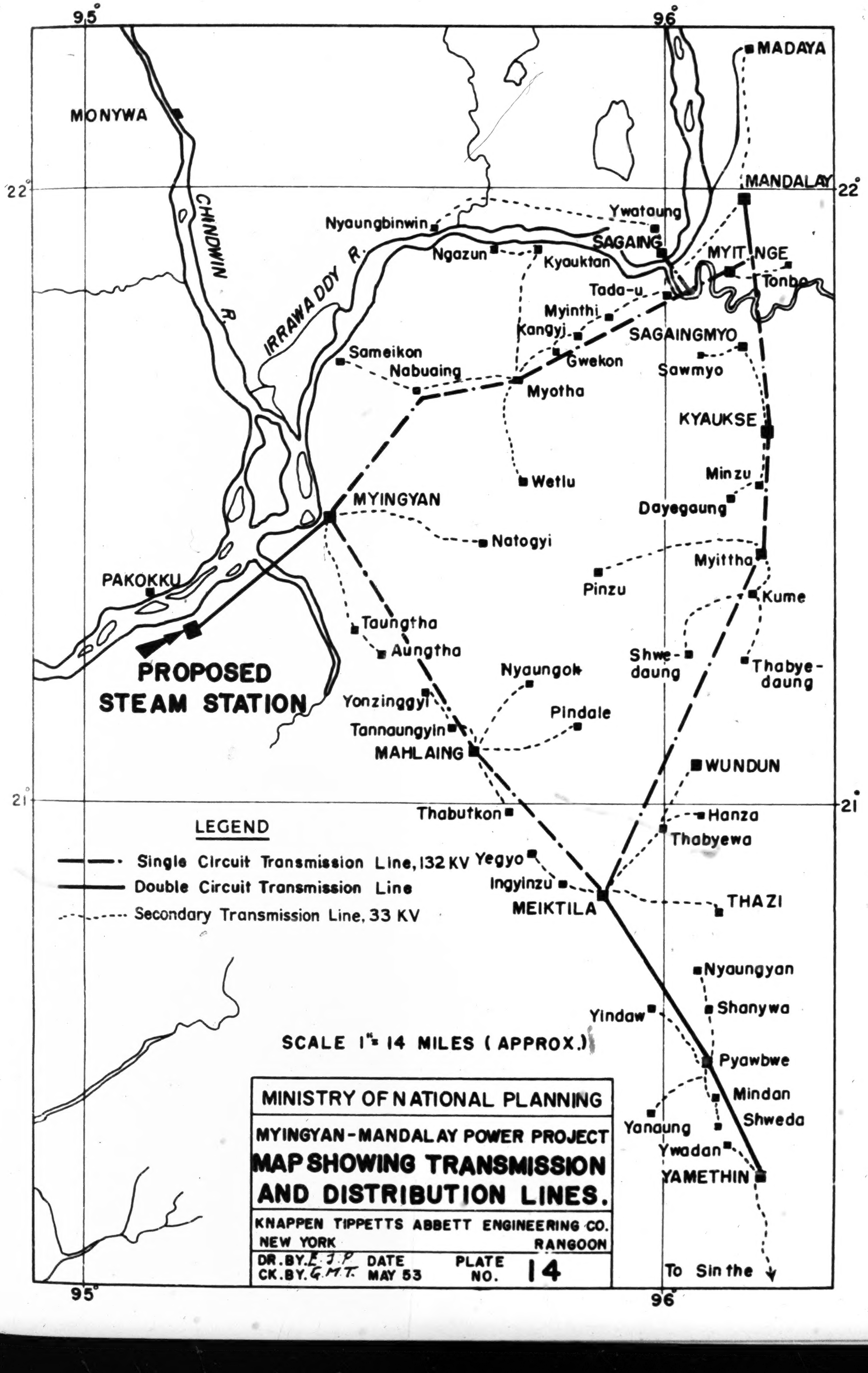
The site of the proposed power station is about 20 miles southwest of the town of Myingyan on the banks of the Irrawaddy River. At this point high ground above river flood levels, navigation facilities for coal handling and ample water for the condensers are available. About a 40-ft. pumping lift would be required from low water to ground level at the plant. The intake would be located on the cutting bank of the river to avoid siltation and the outlet pipe would be submerged in order to recover a part of the pumping lift by siphon action.

c. Access

Railroads and all-weather highways should be extended to provide access to the site of the power station from Myingyan. Regular river steamer service is available via the Irrawaddy. Ease of shipping by both land and river is one of the principal reasons for locating the development at the selected site where zinc ore, coal and finished products can be readily transported.

d. Market Area

The power development is intended primarily to serve the proposed industrial plants near Myingyan


95°
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MADAYA
MONYWA
MANDALAY
Ywataung
Nyaungbinwin
SAGAING
CHINDWIN R.
IRRAWADDY R.
Ngazun
Kyauktan
MYITNGE
Tonbo
Tada-u
Myinthi
Kangyi
SAGAINGMYO
Gwekon
Sameikon
Sawmyo
Nabuaing
Myotha
KYAUKSE
Wetlu
Minzu
MYINGYAN
Dayegaung
Natogyi
Myittha
Pinzu
PAKOKKU
Kume
Taungtha
Aungtha
Shwedaung
Thabyedaung
Nyaungok
PROPOSED STEAM STATION
Yonzinggyi
Pindale
Tannaungyin
MAHLAING
WUNDUN
Thabutkon
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Yegyo
Ingyinzu
MEIKTILA
THAZI
Nyaungyan
Yindaw
Shanywa
Pyawbwe
Mindan
Yanaung
Shweda
Ywadan
YAMETHIN
To Sin the

LEGEND

- Single Circuit Transmission Line, 132 KV
- Double Circuit Transmission Line
- Secondary Transmission Line, 33 KV

SCALE 1" = 14 MILES (APPROX.)

MINISTRY OF NATIONAL PLANNING

MYINGYAN-MANDALAY POWER PROJECT

MAP SHOWING TRANSMISSION AND DISTRIBUTION LINES.

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. E.J.P. DATE MAY 53 PLATE NO. 14
CK. BY. G.M.T.

TABLE XIX – 16
ESTIMATED INCOME AND COST OF ENERGY—1962 and 1966
(Including Steel Mill, Pegu, Henzada and Irrigation Pumping)
Assuming no future hydro development after completion of the Pegu River Development

	1962			*1966*		
Steam Capacity	35,000 kW			40,000 kW		
Hydro Capacity	45,000 kW			45,000 kW		
Annual Revenue	*Sales in Thousand kWh*	*Est. Rate pyas per kWh*	*Annual Revenue in Thousand Kyats*	*Sales in Thousand kWh*	*Est. Rate pyas per kWh*	*Annual Revenue in Thousand Kyats*
Bulk Power, Rangoon	39,900	12·0	4,790	50,800	10·0	5,080
Steel Mill, Rangoon	37,000	10·0	3,700	46,500	9·0	4,190
All Purpose Power, Rangoon	13,500	19·0	2,570	16,200	18·0	2,920
Power, Rangoon	8,000	15·0	1,200	9,400	14·0	1,320
Departmental, Rangoon	1,200	15·0	180	1,600	14·0	220
Public Lighting, Rangoon	6,000	0	0	7,800	0	0
Lighting, Rangoon	45,400	25·0	11,350	59,200	25·0	14,800
,, Other	5,400	38·0	2,050	6,900	38·0	2,620
Bulk Outside Rangoon	3,600	14·0	500	4,600	12·0	550
Irrigation Pumping	21,000	19·0	3,990	29,000	18·0	5,220
Total Sales	181,000		30,330	232,000		36,920
Annual Operating Costs	*Output in Thousand kWh*	*Cost in pyas per kWh*	*Annual Cost Thousand Kyats*	*Output in Thousand kWh*	*Cost in pyas per kWh*	*Annual Cost Thousand Kyats*
Steam Plant	69,000	12·20	8,420	128,000	10·30	13,180
Exist. Dist. System	43,500	5·75	2,500	43,500	5·75	2,500
Pegu Hydro Plant	139,000	4·80	6,670	139,000	4·80	6,670
New Dist. System	164,500	6·08	10,020	223,500	5·61	12,540
Total Cost	208,000		27,610	267,000		34,890
Net Profit			2,720			2,030

and the existing markets at Mandalay, but would also serve Meiktila, Yamethin and smaller communities along the route of the proposed transmission line. Mandalay is an important manufacturing and railroad center, the distributing point for consumer goods arriving from south Burma and from outside. It is the concentration point for agricultural and mining products from Upper Burma. Meiktila and Yamethin are centers of an important agricultural area where irrigation is dominant. Rice, tobacco, sugar, hogs and poultry are major products. The region is largely flat to rolling, about 50% being arable and under cultivation. Paved highways and railroads connect all towns along the transmission line route. The market area is bounded on the north and west by the Irrawaddy, on the south by the Pegu Yomas, and on the east by the Shan escarpment (see map on Plate 14). The population of the area is estimated to have been about 2,100,000 in 1952. The annual income in 1938–39, corrected for the price increase since that time, is estimated at K45 crores.

e. Existing Power Plants

Within the market area the following power plants are operated by the Electricity Supply Board:

	Capacity in Kilowatts	
	1939	*1952*
Myingyan	150	131
Meiktila	40	163
Kyaukse	39	68
Sagaing	56	53
Mandalay	1,145	1,508
Yamethin	44	56

The 1952 rates were Pyas 75 per kWh, 6- to 12-hour service per day, except Mandalay where 24-hour service is given and a sliding scale prevails, Pyas 75 to Pyas 63 per kWh. The Burma Railways operates an

1,150-kW steam plant at Myitnge and a 96-kW diesel plant at Mandalay. The principal load is the carriage and wagon building shop at Myitnge.

f. Prospective Loads

The principal power loads now anticipated for 1957 and 1962 are summarized below:

No.	*Description*	*Demand in Kilowatts.* 1951	1957	1962
1.	Domestic	618	5,745	9,589
2.	Ice Plants	—	350	420
3.	Burma Railways	590	850	1,200
4.	Zinc Reduction	—	7,000	11,700
5.	Sulphuric Acid	—	1,000	1,500
6.	Other Manufactures	—	1,500	2,500
7.	Port Mechanization	—	300	500
8.	Yamethin Pumps	—	600	1,320
9.	Sinthe Pumps	—	800	1,570
	Total	1,208	18,145	30,299

For details of the above summary see Table XIX–17, "Estimated Power Requirements—Mandalay Division and Sagaing Town."

TABLE XIX – 17

UPPER MANDALAY DIVISION AND SAGAING TOWN
ESTIMATED POWER REQUIREMENTS

	1951 (Actual)		*1957 (Estimated)*		*1962 (Estimated)*		*1967 (Estimated)*	
	Annual kWh/cap.	*Population (Thousands)*	*Annual kWh/cap.*	*Population (Thousands)*	*Annual kWh/cap.*	*Population (Thousands)*	*Annual kWh/cap.*	*Population (Thousands)*
Mandalay	3·1	190	15	230	20	280	25	340
Sagaing	4·9	15	10	22	15	30	20	40
Myingyan	4·9	34	15	42	20	50	25	60
Meiktila	6·6	19	10	25	15	30	20	36
Yamethin	—	35	10	42	15	50	20	60
Kyaukse	—	8	10	9	15	12	20	16
Rural	—	1,785	2	1,880	5	1,975	8	2,070

DOMESTIC POWER REQUIREMENTS

Location	*kW max. Demand*	*Load Factor*	*Thous. kWh per year Sales*	*kW max. Demand*	*Load Factor*	*Thous. kWh per year Sales*	*kW max. Demand*	*Load Factor*	*Thous. kWh per year Sales*	*kW max. Demand*	*Load Factor*	*Thous. kWh per year Sales*
Mandalay	356	19	585	1,970	20	3,450	2,560	25	5,600	3,240	30	8,500
Sagaing	44	19	73	125	20	220	206	20	450	366	25	800
Myingyan	76	26	168	288	25	630	456	25	1,000	570	30	1,500
Meiktila	54	27	124	114	25	250	206	25	450	274	30	720
Yamethin	44	—	Incomp.	320	15	420	428	20	750	550	25	1,200
Kyaukse	44	—	,,	68	15	90	103	20	180	146	25	320
Rural	0	—	0	2,860	15	3,760	5,630	20	9,880	9,480	20	16,580
Total Domestic	618	—	Incomp.	5,745		8,820	9,589		18,310	14,626		29,620

BULK POWER REQUIREMENTS

Mandalay Ice	—	—	—	250	60	1,310	300	60	1,570	400	60	1,960
Myingyan Ice	—	—	—	50	60	262	60	60	315	80	60	395
Yamethin Ice	—	—	—	50	60	262	60	60	315	80	60	395
Burma Railways	590*	11	544	850	20	1,490	1,200	30	3,150	1,500	30	3,950
Myingyan Zinc	—	—	—	7,000	60	36,800	11,700	80	82,000	14,500	80	101,700
,, Sulphur	—	—	—	1,000	40	3,600	1,500	50	6,570	2,000	50	8,760
,, Other	—	—	—	1,500	30	3,940	2,500	30	6,570	3,000	30	7,890
Port Mechanization	—	—	—	300	30	790	500	30	1,310	1,500	30	3,930
Yamethin Pumps	—	—	—	600	17	890	1,320	19	2,200	2,200	20	3,850
Sinthe Pumps	—	—	—	800	19	1,330	1,570	25	3,430	2,800	25	6,120
Total Bulk	590	—	544	12,400		50,674	20,710		107,430	28,060		138,950
Bulk and Domestic	1,208		Incomp.	18,145		59,494	30,299		125,740	42,686		168,570
Max. Simultaneous Demand at Generators	—			16,500	41		28,000	52		39,000	49	

* Installed capacity 1,250 kilowatts.

g. Paunglaung Hydroelectric Project

An investigation has been made of several sources of hydroelectric power to supply the Myingyan–Mandalay area. The most economical and simplest project to construct is the Paunglaung River project near Pyinmana. Details of this project are discussed in para. G of this chapter. From this project power can be supplied at the load centers for Pyas 4·0 per kWh for the initial development and Pyas 3·5 per kWh, ultimately after completion of upstream regulating dams. The initial Paunglaung power project should be completed in 1960 in order to avoid the addition of a fourth turbine and generator at the steam plant. This development is indicated in Table XIX–21 (*see p. 609*). If Paunglaung power is not available by 1960 the additional unit must be provided at the Myingyan steam station, assuming market growth as shown in Table XIX–17.

h. Kalewa Coal

If the Kalewa coal project is promptly approved and implemented, a dependable supply of coal will be available. The coal will move to the steam plant via river barges. If developed as planned, coal can be delivered to Myingyan starting in 1957 at a price of approximately K42 per ton in the stock pile (see Table XIX–18).

TABLE XIX – 18

MYINGYAN-MANDALAY POWER PROJECT

Comparison of Existing and Proposed Steam Plants

Name of Plant	*Ahlone Power Station*	*Mandalay Power Station*	*Proposed Myingyan Power Station*
Location	Rangoon	Mandalay	Myingyan
Operating Co.	Rangoon Elect. Tram and Supply	Elect. Supply Board	Elect. Supply Board
kWh Generated 1952	46,500,000	—	77,500,000*
No. of Turbo Alternators	2	2	3
Capacity Each, kW	10,000	550	10,000
Voltage	6,600	400/440	6,600
Power Factor	0·9	0·8	0·8
R.P.M.	3,000	1,000	3,000
Steam Pressure	425	213	600
Steam Temperature	780	518	825
Year Manufactured	1949	World War II	—
No. of Boilers	4	2	3
Steam Rate, lbs./hour per boiler	60,000	10,000	120,000
Type of Fuel	Coal or oil	oil	coal
Fuel Rate lbs./kWh (coal rating)	1·65	3·3	1·25*
Cost of Coal, Ks/Ton	90	—	42·0*
Cost of Oil Ks/Ton	161	—	—
BTU/lb., Coal	12,100	—	11,000†
BTU/lb., Oil	18,776	—	—

*Estimated for 1957. †Kalewa Coal.

i. Recommendation of Steam Plant

The Myingyan steam plant is a moderate low cost power development with relatively short transmission line to nearby cities to be maintained and protected from vandalism. It is intended to serve proposed industrial plants near Myingyan and existing markets at Mandalay, Meiktila and Yamethin. The power plant, transmission and distribution systems can be completed by December 31, 1956, to utilize Kalewa coal and to supply the new industrial plants which should be completed at that time. The development lends itself to incorporation in a more extensive power system connected to the proposed Paunglaung River project, but until the latter is constructed the Myingyan steam station will serve the Mandalay Division industrial and domestic markets. Both steam and hydroelectric power are essential in the near future, the one to operate as a base load plant from which it would be relatively efficient and the other to carry base load and peaks, being equally efficient for either purpose. Accordingly, it is concluded that field investigations at Myingyan should be commenced as soon as possible and that construction should be scheduled for 1956 completion.

j. Technical Details

(1) Power Station Site

The site selected is on the east bank of the Irrawaddy about 20 miles southwest of Myingyan where river navigation is most favorable. The site is on high ground that has offered resistance to erosion by the river. It is on a cutting bank which will avoid siltation at the proposed dock and pump intake. The site comprises 20 acres, half of which is reserved for coal handling and storage. The other half provides space for the proposed power generating station with additional space for expansion. Tracks would lead from the turbine room and the ash hoppers to the dock. Railroad and highway connections from Myingyan would be constructed for the movement of ore to the zinc reduction plant and for general hauling.

(2) Fuel Handling

A bulkhead type dock of sufficient height to clear the maximum flood by five feet would accommodate the coal barges. On the dock would be installed a track mounted crane and conveyor belts to move the coal to the stock pile. The storage area would approximate a 140-degree sector, 350 ft. radius, served by a drag scraper located at the center of the arc. This would permit the storage of nine months' supply at 12 ft. depth. The scraper would feed to a vertical lift bucket conveyor, which dumps onto an overhead horizontal belt feeding the coal hoppers and pulverizers. The pulverizers should be capable of supplying 13 tons per hour to each boiler. If low cost fuel oil becomes available at Myingyan, conversion of the boilers to fuel oil can be readily accomplished (see Plate 15 for the general layout of steam plant).

(3) Steam Generation

The boiler should be of the water tube type fed by 357° F. water from the preheater. Each boiler in conjunction with economizers and superheaters would be capable of continuously evaporating 120,000 lbs. of water per hour into steam at 600 lbs. per sq. in. gauge pressure at the superheater. The superheater would be integral with the boiler and designed to produce a final steam temperature of 850° F. at the maximum boiler rating. Forced draft and induced draft fans will be designed to provide air and to draw waste gases from the boiler when steaming at its maximum continuous rating. Grit catchers for the stack will be included together with accessories for the collection and disposal of grit. Soot blowers provided at necessary points on the boilers, superheaters and economizers would be connected to a flue dust suction system leading to a central dust hopper. Ash hoppers under each boiler would discharge into a conveyor system leading to a central ash hopper. The central hoppers would dispose directly into dump cars mounted on a track leading to the dock. The stack should be of the self-supporting steel type, designed to clear the highest portion of the powerhouse structure (see Plate 16 for the "Steam and Electrical Diagram for One Unit").

(4) Boiler Feed Water

Feed water would be supplied from tube wells. Make-up water would pass through an evaporator heated by bleed steam from the turbines and saturated steam from the boilers. Thence water from the evaporators and from the feed heaters would enter the deaerators, after three stages of heating supplied by main and bleed steam. Two boiler feed pumps in parallel would supply each boiler, one motor-operated and the other turbine-operated. Each pump should be of the centrifugal type capable of delivering 120,000 lbs. per hour of feed water against a pressure of 720 lbs. per sq. in.

(5) Turbo Alternator Sets

Three turbine generator units would be provided initially. Each turbine would be of sufficient capacity to drive the generator continuously at the specified rating when supplied with steam at 600 lbs. per sq. in. gauge pressure and 825° F. temperature at the turbine stop valve and when exhausting into a 2-inch vacuum. Each generator should have a maximum continuous rating of 10,000 kilowatts, at 80% P.F., 3,000 r.p.m., 3 phase, 50 cycles, 6,600 volts.

(6) Condenser Water

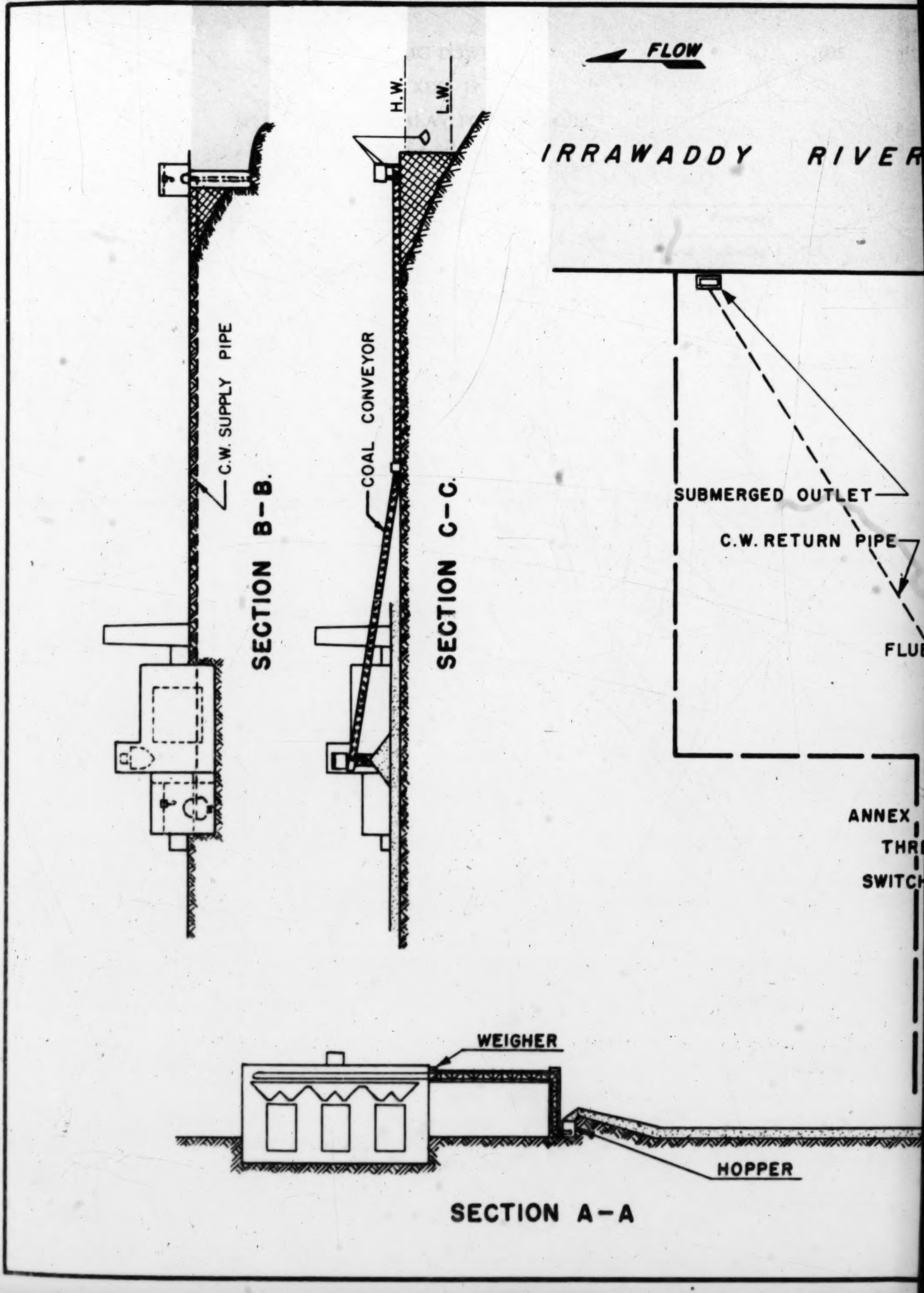
The condenser water intake should be located in a wet well at the outer corner of the dock. Three mixed-flow axial pumps should deliver 11,000 gallons per minute each against a net head of 25 ft. when running at full speed. The head is based on recovering part of the gross head by siphon action. At the intake, trash racks to remove coarse materials should be installed flush with the dock face to be largely self cleaning. The water conduit should be of such diameter as to avoid siltation. Each condenser should have double inlets arranged for reversing the flow and flushing out the silt. Condensers would be of the horizontal surface type placed under the turbine exhaust flange, designed for the steam to flow over and the water through the tubes.

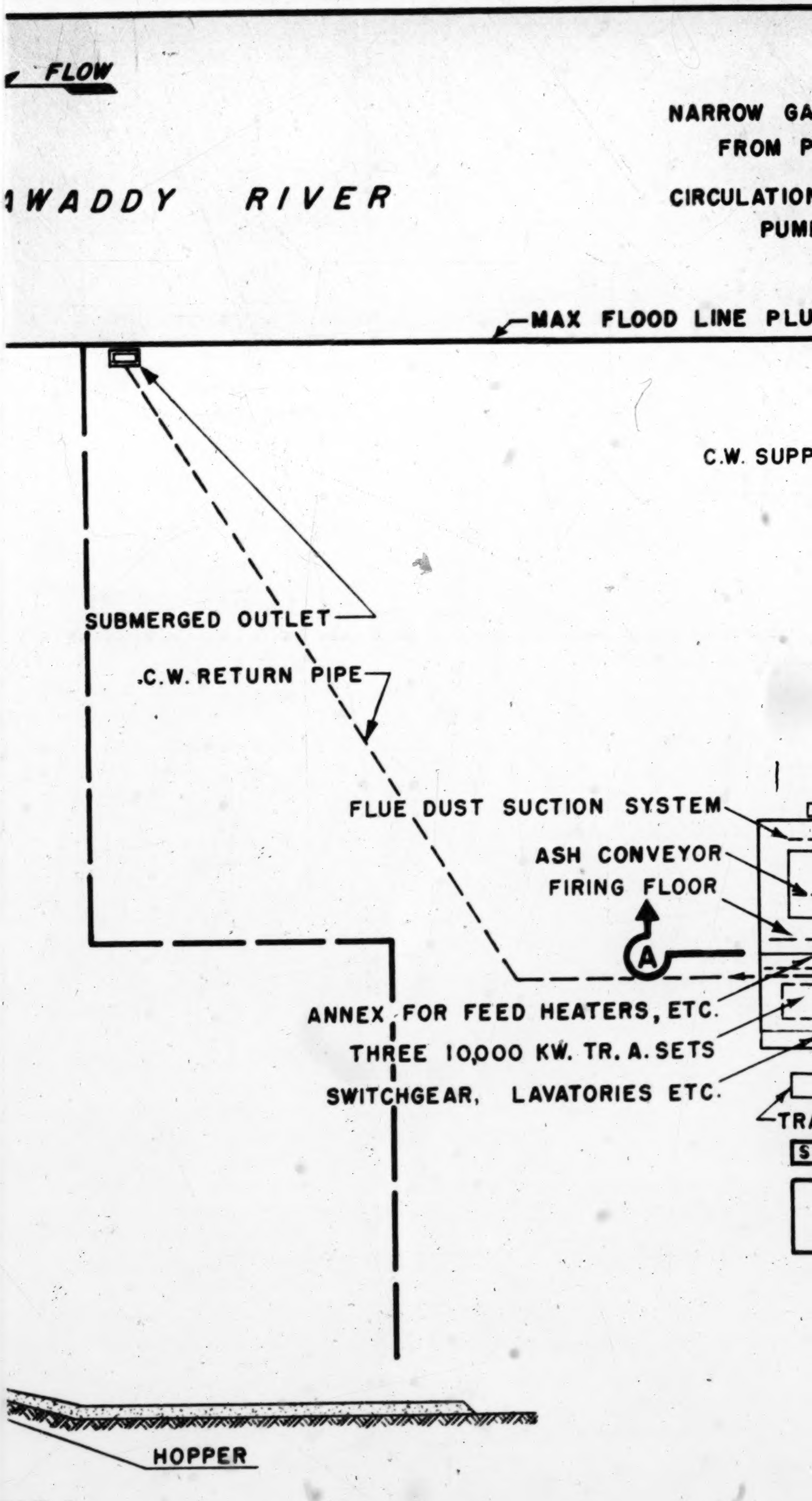
(7) Substation

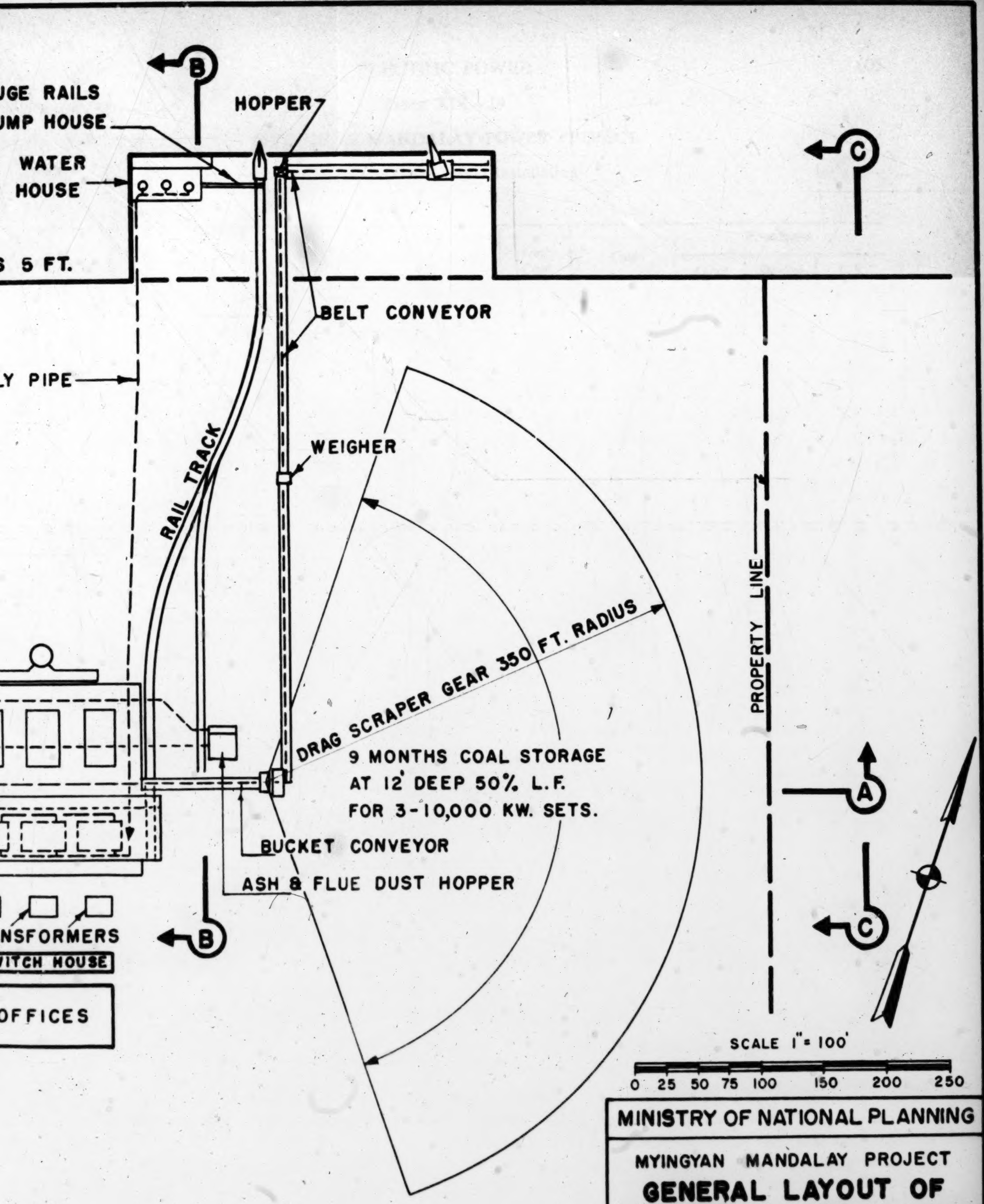
An outdoor substation would be provided with the main transformers located near the powerhouse and switch gear in the powerhouse. The initial capacity would be 30,000 kW with space for expansion. Voltage would be stepped up from 6.6 to 132 kV at the transformer bank.

(8) Transmission Lines

Initial lines should consist of a 132-kV 30,000-kW double circuit from the power station to Myingyan and a single circuit loop from Myingyan passing north-eastward to Mandalay thence south through Myitnge and Kyaukse to Meiktila and thence returning to Myingyan. A branch line across the Ava Bridge would serve Sagaing. A double circuit line would lead from Meiktila to Yamethin. In future it would be connected to the proposed Paunglaung hydroelectric development by a double circuit 132-kV line. The towns along the loop system would receive continuous service, unless outages occurred simultaneously at two points in the loop. The proposed zinc reduction plant should be located adjacent to the power station and would be served with a 6.6. kV line leading from the powerhouse. Conversion to direct current would be provided by the zinc plant. All transmission lines would be adjacent to existing or proposed highways and railroads, crossing generally flat rice lands through which no clearing would be required.


FLOW
H.W.
L.W.
IRRAWADDY RIVER
C.W. SUPPLY PIPE
SECTION B-B.
COAL CONVEYOR
SECTION C-C.
SUBMERGED OUTLET
C.W. RETURN PIPE
FLUE
ANNEX
THR
SWITCH
WEIGHER
HOPPER
SECTION A-A


FLOW
NARROW GA
FROM P
AWADDY RIVER
CIRCULATIO
PUM
MAX FLOOD LINE PLU
C.W. SUPP
SUBMERGED OUTLET
C.W. RETURN PIPE
FLUE DUST SUCTION SYSTEM
ASH CONVEYOR
FIRING FLOOR
A
ANNEX FOR FEED HEATERS, ETC.
THREE 10,000 KW. TR. A. SETS
SWITCHGEAR, LAVATORIES ETC.
TR
S
HOPPER
-A


B
UGE RAILS
UMP HOUSE
HOPPER
WATER HOUSE
C
S 5 FT.
BELT CONVEYOR
LY PIPE
WEIGHER
RAIL TRACK
PROPERTY LINE
DRAG SCRAPER GEAR 350 FT. RADIUS
9 MONTHS COAL STORAGE
AT 12' DEEP 50% L.F.
FOR 3-10,000 KW. SETS.
A
BUCKET CONVEYOR
ASH & FLUE DUST HOPPER
C
NSFORMERS
B
WITCH HOUSE
OFFICES
SCALE 1" = 100'
0 25 50 75 100 150 200 250

MINISTRY OF NATIONAL PLANNING

MYINGYAN MANDALAY PROJECT

GENERAL LAYOUT OF PROPOSED STEAM PLANT

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON.

DR. BY E.J.P. DATE PLATE NO 15
CK. BY GMT MAY 53.

TABLE XIX - 19

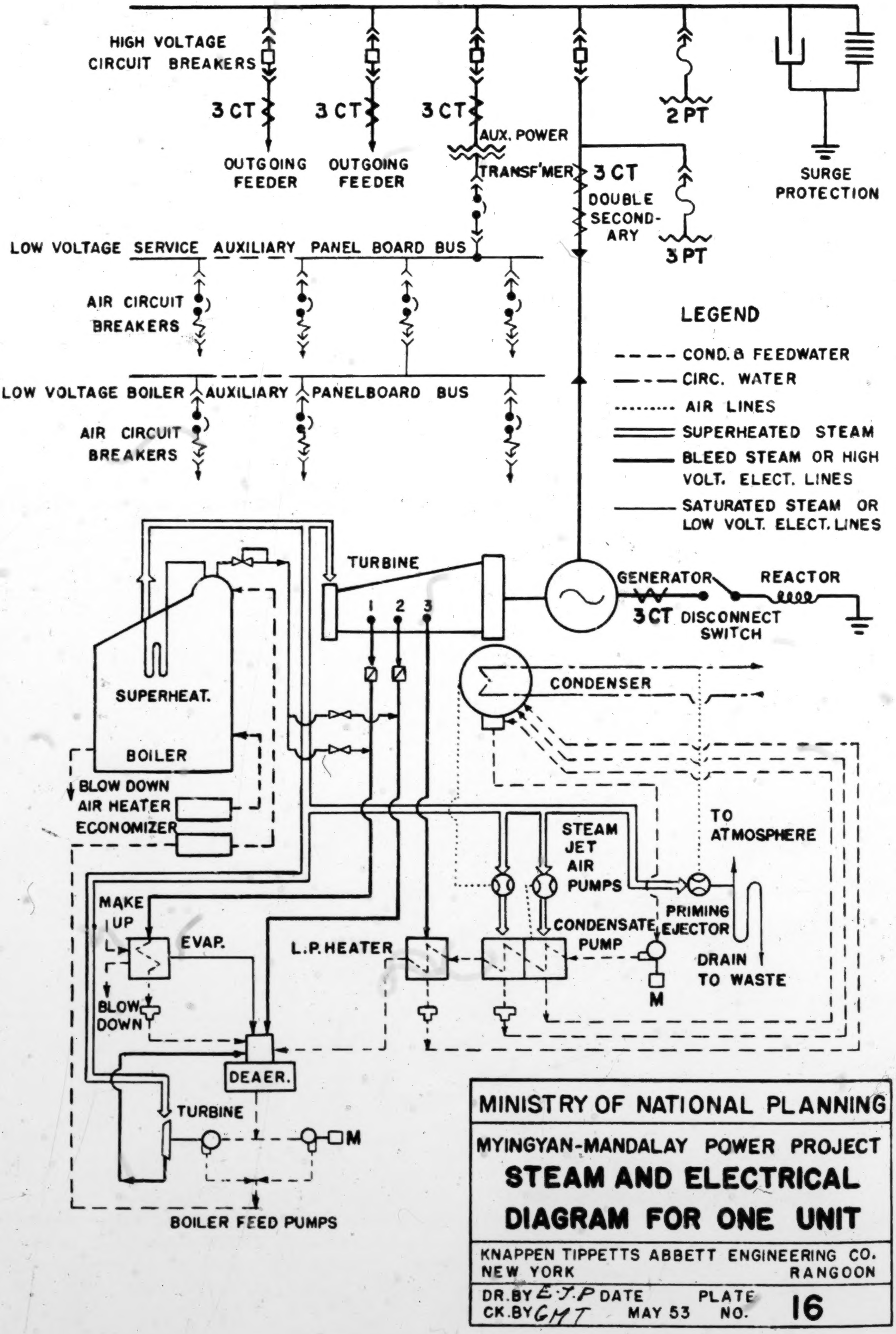
MYINGYAN-MANDALAY POWER PROJECT

Estimated Cost—Initial Installation
(U.S. Dollars)

No.	Description	Quantity	Unit	Unit Cost	Cost	Percentage		
						Local	Sterling	U.S.
				$	$			
1	Investigation and Design	l.s.	—	—	300,000	20	40	40
2	Land Purchase	20	acre	200	4,000	100	—	—
3	Clearing and Grading	10	acre	500	5,000	80	—	20
4	Access Road	1	mi.	10,000	10,000	70	20	10
5	Water Front Riprap	3,000	s.y.	5·00	15,000	60	20	20
6	Sheet Pile Dock	250,000	lbs.	0·50	125,000	40	10	50
7	Dock Crane	l.s.	—	—	45,000	20	60	20
8	Belt Conveyor	500	l.f.	40·00	20,000	40	—	60
9	Drag Line	l.s.	—	—	30,000	20	60	20
10	Coal Pulverizers	l.s.	—	—	120,000	40	—	60
11	Power Station, Foundation	30,000	s.f.	7·00	210,000	50	—	50
12	Power Station, Superstructure	1,120,000	c.f.	0·50	560,000	60	30	10
13	Boilers and Stack	360,000	lbs./hr.	4·25	1,530,000	40	30	30
14	Boiler Auxiliaries	l.s.	—	—	150,000	40	50	10
15	Piping	300,000	lbs.	0·25	75,000	40	50	10
16	T.A. Sets and Condensers	3	each	600,000	1,800,000	30	—	70
17	Turbine Room Crane	l.s.	—	—	50,000	20	60	20
18	Condenser Water	l.s.	—	—	120,000	50	—	50
19	Induced Draft System	l.s.	—	—	80,000	40	50	10
20	Oil Pumping and Heating	l.s.	—	—	20,000	30	60	10
21	Electrical Controls	l.s.	—	—	100,000	20	20	60
22	Living Quarters	l.s.	—	—	200,000	40	50	10
23	Flood Protection	2,000	l.f.	50·00	100,000	60	20	20
	Subtotal				5,669,000			
24	Substation	l.s.	—	—	250,000	20	—	80
25	Transmission Line	181	mi.	8,000	1,450,000	50	30	20
26	,, ,,	63	,,	15,000	945,000	50	30	20
27	,, ,,	5	,,	6,000	30,000	50	30	20
	Subtotal				8,344,000			
28	Engineering and Contingencies	20%			1,656,000			
	Total Power Station and T.L.				10,000,000	41·0	22·4	36·6
29	Distribution System				3,030,000	50	30	20
	Grand Total				13,030,000	43·1	24·2	32·7

(9) Distribution System

The present distribution system at Mandalay is maintained and administered by the Electricity Supply Board. Details of the proposed new distribution system in Mandalay, Myingyan, Meiktila and other communities would be determined after obtaining further field data. Like the Pegu system and for the same reasons the Myingyan distribution system should be developed under the close control of a private management firm. The franchising and financing of the distribution system should be handled as recommended for the Pegu project (paragraph E-1-v of this chapter).


HIGH VOLTAGE CIRCUIT BREAKERS
3 CT
3 CT
3 CT
OUTGOING FEEDER
OUTGOING FEEDER
AUX. POWER TRANSF'MER
3 CT
DOUBLE SECONDARY
2 PT
3 PT
SURGE PROTECTION
LOW VOLTAGE SERVICE AUXILIARY PANEL BOARD BUS
AIR CIRCUIT BREAKERS
LOW VOLTAGE BOILER AUXILIARY PANELBOARD BUS
AIR CIRCUIT BREAKERS
LEGEND
COND. & FEEDWATER
CIRC. WATER
AIR LINES
SUPERHEATED STEAM
BLEED STEAM OR HIGH VOLT. ELECT. LINES
SATURATED STEAM OR LOW VOLT. ELECT. LINES
TURBINE
1
2
3
GENERATOR
3 CT
DISCONNECT SWITCH
REACTOR
CONDENSER
SUPERHEAT.
BOILER
BLOW DOWN
AIR HEATER
ECONOMIZER
STEAM JET AIR PUMPS
TO ATMOSPHERE
PRIMING EJECTOR
CONDENSATE PUMP
M
DRAIN TO WASTE
MAKE UP
EVAP.
L.P. HEATER
BLOW DOWN
DEAER.
TURBINE
M
BOILER FEED PUMPS

MINISTRY OF NATIONAL PLANNING

MYINGYAN-MANDALAY POWER PROJECT

STEAM AND ELECTRICAL DIAGRAM FOR ONE UNIT

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.T.P DATE PLATE
CK. BY GMT MAY 53 NO. 16

k. Construction Materials

(1) Local purchase

For estimating purposes it is assumed that local purchases will include dock fenders and facing timber; water front riprap; cement, aggregates, brick and tile for the powerhouse; framing, roofing and lumber for living quarters.

(2) Purchase from Countries in the "Soft Currency" Area

This may include structural steel, dock crane, drag line excavator, boilers, turbine room crane, plumbing and electrical fixtures, reinforcing steel, sump pumps, substation, transmission and distribution equipment, and steel erection equipment.

(3) Purchase from the United States

This may include sheet piling, condenser water pumps, belt conveyors, pulverizers, turbines and generators, earth moving equipment and concrete plant.

l. Contracts

Contracts for design, construction, supervision of construction and operation should be handled in the same manner as for the Pegu hydroelectric project (paragraphs E–1–n, o, p and q of this chapter). Design and specifications should be completed in nine months, but the dock and powerhouse layout should be accomplished in three months to expedite foundation work. For this work the engineering fees should conform with the standards of the American Society of Mechanical Engineers or their equivalent.

m. Estimated Costs

Quantities and costs are based on incomplete data including an aerial mosaic of the industrial site at Myingyan and the Burma Survey (1 inch = 1 mile) maps for location of the transmission lines, (see table XIX–19, "Estimated Cost—Initial Installation"). Excavation, concrete and steel costs are based on prices for similar work recently completed in Burma. Boilers, turbines, generators and electrical controls are estimated from preliminary quotations from American and British manufacturers. A contingency and engineering factor of 20% has been allowed in addition to a fee of approximately 3% for investigation and design. Unit charges for the distribution system are assumed as follows:

	Pyas per kWh
Zinc Reduction Plant	1·0
Sulphuric Acid and Fertilizer Plants	2·0
Other Consumers	8·0

The last item is somewhat greater than the present costs for the Rangoon metropolitan area, because of the more scattered communities to be supplied. The annual charges capitalized at 12% give the total estimated cost of the distribution system presented in Table XIX–19. The over-all cost of steam station, transmission line and distribution system are conservative in comparison with the actual cost of similar projects completed recently in other countries.

n. Production Costs

The estimated annual cost of power at the load center is computed as follows:

CAPITAL RECOVERY WITH INTEREST AT 4·25%*

Description	*Life in Years*	*Factor*	*Investment* $	*Annual Cost* $
Boilers, Elect. Controls	20	·0752	2,200,000	165,000
Steam Turbines, etc.	22	·0714	2,400,000	171,000
Trans. Lines	35	·0555	2,425,000	134,000
Civil Eng. Works	50	·0491	2,975,000	146,000
Capital Recovery Charges				616,000

Capital Recovery Charges (balance brought forward)	$616,000
Labor Cost	77,000
Supplies, Repairs, Contingencies	21,000
Transmission Line Maint. (1·5% of Trans. Line Investment)	36,000
Fuel Cost (1957 market) $\frac{42{\cdot}0}{4{\cdot}75} \times \frac{1{\cdot}25}{2{,}240} \times 59{,}494{,}000 \times 1{\cdot}3 =$	381,000
Total Annual Cost	$1,131,000

Cost per kWh at load center:

$$1{,}131{,}000 \div (59{,}494{,}000 \times 1{\cdot}15) = 16{\cdot}52$$ mills or 7·88 pyas

*Interest has been assumed at 4% for 75% of the total investment and 5% for the remainder.

Future costs are as follows:

	1962	*1967*
Plant capacity (without hydroelectric development)	40,000 kW	50,000 kW
Capital recovery charges	$822,000	$1,025,000
Labor, supplies, etc.	116,000	137,000
Fuel cost	806,000	1,080,000
Transmission line maint.	48,000	60,000
	$1,792,000	$2,302,000
Cost per kWh at load center, mills	12·37	12·62
,, ,, ,, ,, pyas	5·90	6·01

o. Distribution Costs

Without complete details it is believed that 8 pyas (1·68 cents) per kWh is ample allowance for a new distribution system containing about 50% domestic load as given in Table XIX–17 for 1957. The allowance has been reduced to 7·0 pyas for 1962 and 6·5 pyas for 1967 when loads are greater and system inefficiencies have been reduced. The annual cost for

1957–1967 and the initial investment are computed as follows:

	1957	*1962*	*1967*
Zinc Plant	K 3,68,000	K 6,60,000	K 7,10,000
Sulphur and Other Mfg.	1,51,000	2,10,000	2,30,000
General Sales	12,10,000	21,40,000	32,70,000
Annual Cost	K 17,29,000	K 30,10,000	K 42,10,000
Investment at 12%	K1,44,00,000*	K2,51,00,000	K3,51,00,000
,, in dollars	$3,030,000	$5,280,000	$7,390,000
Capital Recovery with interest at 4·25%			
Amortization—20 year life			·075
Operation and Maintenance			·045
Total Cost			·120

*Of this amount K71,79,000 or $1,510,000 is provided in the initial diesel program for supply of the Meiktila area.

p. Electric Rates

The proposed domestic rates as given in Table XIX–20 range from 50 pyas per kWh for rural (villages of 2,000 to 8,000 population) to 40 pyas, urban, in 1957. It is estimated that these rates can be reduced to 40 and 30 pyas respectively by 1967. The present rates are 75 pyas for all towns except Mandalay, where the following rates exist.

First	100 units	Pyas 75	per kWh
Second	,, ,,	,, 69	,, ,,
All other	,,	,, 63	,, ,,

TABLE XIX – 20

MYINGYAN–MANDALAY POWER PROJECT

ESTIMATED REVENUE & COST OF ENERGY—1957 to 1967 inclusive

(All steam power development without benefit of the future Paunglaung Hydro development)

	1957			*1962*			*1967*		
Plant Capacity	30,000 kW			40,000 kW			50,000 kW		
Annual Revenue	*Sales in Thous. kWh*	*Est. Rate Pyas/ kWh*	*Annual Revenue Thous. K*	*Sales in Thous. kWh*	*Est. Rate Pyas/ kWh*	*Annual Revenue Thous. K*	*Sales in Thous. kWh*	*Est. Rate Pyas/ kWh*	*Annual Revenue Thous. K*
Domestic, Urban	5,060	40	2,030	8,430	35·0	2,950	13,040	30	3,910
,, Rural	3,760	50	1,880	9,880	45·0	4,450	16,580	40	6,640
Ice Plants	1,834	25	460	2,200	20·0	440	2,750	15	410
Burma Railways	1,490	25	370	3,150	20·0	630	3,950	15	590
Zinc Plant	36,800	5	1,840	82,000	4·5	3,690	101,700	4	4,060
Sulphuric Acid	3,600	10	360	6,570	9·0	590	8,760	8	700
Other Plants	3,940	10	390	6,570	9·0	590	7,890	8	630
Port Mechanization	790	25	200	1,310	20·0	260	3,930	15	590
Irrigation Pumping	2,220	25	560	5,630	20·0	1,120	9,970	15	1,490
Total Sales	59,494		8,090	125,740		14,720	168,570		19,020
Annual Operating Cost	*Sales in Thous. kWh*	*Cost in Pyas/ kWh*	*Annual Cost Thous. K*	*Sales in Thous. kWh*	*Cost in Pyas/ kWh*	*Annual Cost Thous. K*	*Sales in Thous. kWh*	*Cost in Pyas/ kWh*	*Annual Cost Thous. K*
Capital Recovery	—	—	2,920	—	—	3,910	—	—	4,870
Labor, Supplies, etc.	—	—	470	—	—	550	—	—	650
Fuel Cost	—	—	1,810	—	—	3,830	—	—	5,140
Trans. Line Maintenance	—	—	170	—	—	230	—	—	290
Zinc Plant Distribution	36,800	1	370	82,000	0·8	660	101,700	0·7	710
Sulphuric and Other	7,540	2	150	13,140	1·6	210	16,650	1·4	230
General Distribution	15,154	8	1,210	30,600	7·0	2,140	50,220	6·5	3,270
Total Costs			7,100			11,530			15,160
Net Profit			990			3,190			3,860

TABLE XIX – 21

MYINGYAN–MANDALAY POWER PROJECT

ESTIMATED REVENUE AND COST OF ENERGY—1957 to 1967 inclusive

(Steam electric station supplemented by hydroelectric power from Paunglaung development)

	1957			*1962*			*1967*		
Steam Capacity	30,000 kW			30,000 kW			30,000 kW		
Hydro Capacity	—			40,000			80,000		
Annual Revenue	*Sales in Thous. kWh*	*Est. Rate Pyas/ kWh*	*Annual Revenue Thous. K*	*Sales in Thous. kWh*	*Est. Rate Pyas/ kWh*	*Annual Revenue Thous. K*	*Sales in Thous. kWh*	*Est. Rate Pyas/ kWh*	*Annual Revenue Thous. K*
Domestic, Urban	5,060	40·0	2,030	8,430	35·0	2,950	13,040	30·0	3,910
,, Rural	3,760	50·0	1,880	9,880	45·0	4,450	16,580	40·0	6,640
Ice Plants	1,834	25·0	460	2,200	20·0	440	2,750	15·0	410
Burma Railways	1,490	25·0	370	3,150	20·0	630	3,950	15·0	590
Zinc Plant	36,800	5·0	1,840	82,000	4·5	3,690	101,700	4·0	4,060
Sulphuric Acid	3,600	10·0	360	6,570	9·0	590	8,760	8·0	700
Other Plants	3,940	10·0	390	6,570	9·0	590	7,890	8·0	630
Port Mechanization	790	25·0	200	1,310	20·0	260	3,930	15·0	590
Irrigation Pumping	2,220	25·0	560	5,630	20·0	1,120	9,970	15·0	1,490
Total Sales	59,494		8,090	125,740		14,720	168,570		19,020

Annual Operating Cost	*Sales in Thous. kWh*	*Cost in Pyas/ kWh*	*Annual Cost Thous. K*	*Sales in Thous. kWh*	*Cost in Pyas/ kWh*	*Annual Cost Thous. K*	*Sales in Thous. kWh*	*Cost in Pyas/ kWh*	*Annual Cost Thous. K*
Steam Plant Capital	—	—	2,920	—	—	2,920	—	—	2,920
,, ,, Labor, etc.	—	—	470	—	—	480	—	—	500
Fuel Cost	77,400*	2·33	1,810	86,200*	2·33	2,010	100,000*	2·33	2,330
Trans. Line Maintenance	—	—	170	—	—	230	—	—	290
Hydro Plant	—	—	—	68,500†	4·0	2,730	105,200†	4·0	4,210
Zinc Plant Dist.	36,800	1·0	370	82,000	0·8	660	101,700	0·7	710
Sulphuric and Other	7,540	2·0	150	13,140	1·6	210	16,650	1·4	230
General Distribution	15,154	8·0	1,210	30,600	7·0	2,140	50,220	6·5	3,270
Total Costs			7,100			11,380			14,460
Net Profit			990			3,340			4,560

* Units generated in steam plant. † Net supplied by hydro at load center

There is no rural supply at present. Small industries such as sugar mills, pumping plants, ice plants and port mechanization would receive a rate of 25 pyas per kWh initially and 15 pyas in the future. Large industries, sulphuric acid and fertilizer plants would receive a rate of 10 pyas per kWh initially and 8·0 pyas in the future. The zinc reduction plant would receive a rate of 5·0 pyas per kWh initially and 4·0 pyas in the future. As recommended for the Pegu project a Government rate board should establish rates for the Myingyan–Mandalay area based on the recommendations of the Electricity Supply Board and the managers of the distribution systems.

q. Ownership and Operation

The steam station and transmission system like the Pegu power plant and transmission line should be owned and operated by the Government of Burma with the Electricity Supply Board controlling all engineering, construction and operating contracts. The distribution system, financing, marketing and granting of franchises should also be handled as for the Pegu system.

r. Conclusion

In view of the favorable conditions for the generation of moderate low cost power using Kalewa coal and the ample prospective markets in a prosperous region able to absorb the output, it is recommended that the preliminary investigations and design proceed at once. If cond'tions are found satisfactory detailed design and construction should be expedited to meet the estimated demands of the market area at the end of 1956.

3. SAINGDIN FALLS HYDROELECTRIC PROJECT

a. General

In developing the Saingdin Falls power project the Government's objective is to supply a substantial block of low cost power for domestic and industrial use in an area which is now predominantly agricultural. Industrial loads will include Government sponsored pulp and paper factories, jute bag factories, brick and roof tile plants, irrigation and domestic water supply and carbide and other chemical plants. Secondary benefits from the Saingdin Reservoir would include a large year round supply of clear water for domestic, industrial or irrigation uses. Minor flood control and navigation benefits would be realized also. Considerable Government support for the project has been generated due to the rapid postwar development in the Chittagong area of East Pakistan about 100 miles northwest of the power site. There is also strong local support with ample income to pay the annual power bill.

b. Location

The site of the proposed development is at Saingdin Falls on the Saingdin River about 50 miles north of Akyab and ten miles east of Buthidaung, headquarters for Government activity in northern Akyab District. The Falls are located six miles upstream from the junction of the Saingdin and Mayu Rivers, where both are tidal estuaries. The tidal condition extends to the Falls, which are 70 ft. in height. Map studies, field reconnaissance and discussion with residents of the district indicate no other falls in the Akyab District of equal volume and height. A natural storage basin 35 miles in length at the 150-ft. contour above low water also favors the site. Available storage will carry through a drought extending over a period of several years.

c. Access

Small boats provide access from Akyab to the Falls via the Mayu and Saingdin Rivers. At normal low water the governing depth for navigation is about four feet. Air service to Akyab is provided by the Union of Burma Airways (Douglas DC-3 planes), there being four flights a week from Rangoon. Regular coastal shipping service is available between Rangoon and Akyab. Seagoing ships call at Akyab for rice and rice products during rice shipping season. Akyab has an excellent deep water port to receive ocean ships but heavy cargo must be transferred by lighter from ship to shore or to the dam site. The district is isolated from central Burma by the Arakan Mountains and there are are no motorable roads or railroads connecting the two regions.

d. Market Area

The Akyab District and adjacent areas totalling about 8,000 square miles comprise the market area for the Saingdin Falls power project. About 25% of the area is arable and under cultivation. Most of the remaining 75% is rolling to rugged and not suitable for agriculture. The hills and mountains are generally covered with forests which include extensive areas of dense bamboo suitable for the manufacture of paper. The area is bounded on the north by Pakistan; on the east by the Arakan Mountains; and on the south and west by the Bay of Bengal (see Plate 17).

e. Existing Development

The population of the Akyab District is 840,000 and that of the market area is somewhat greater. The income of the area in 1938–39, corrected for increase in the price level since that time, is estimated at K25,00,00,000. The per capita income was slightly (perhaps 5%) higher than for Burma as a whole. The population is engaged principally in the production of rice and its export to India. Fruit, vegetables, poultry, tobacco, fish, bamboo products and brick are produced for local use. Bazaars are stocked with cheap cloth, low cost merchandise and a few canned foods. Movement of goods and food is normally by river steamers, sampans and dugout canoes. Surplus earnings appear to be spent on ornaments ranging from rough tin bangles up to gold and precious stones: and on costly pagoda temples and religious shrines.

f. Future Development

(1) Pulp and Paper

The Government is actively promoting the construction of a pulp and paper mill, using the local bamboo as pulp wood. Complete investigation by experts has verified that the bamboo supply is ample to sustain a total output of at least 100 tons per day.

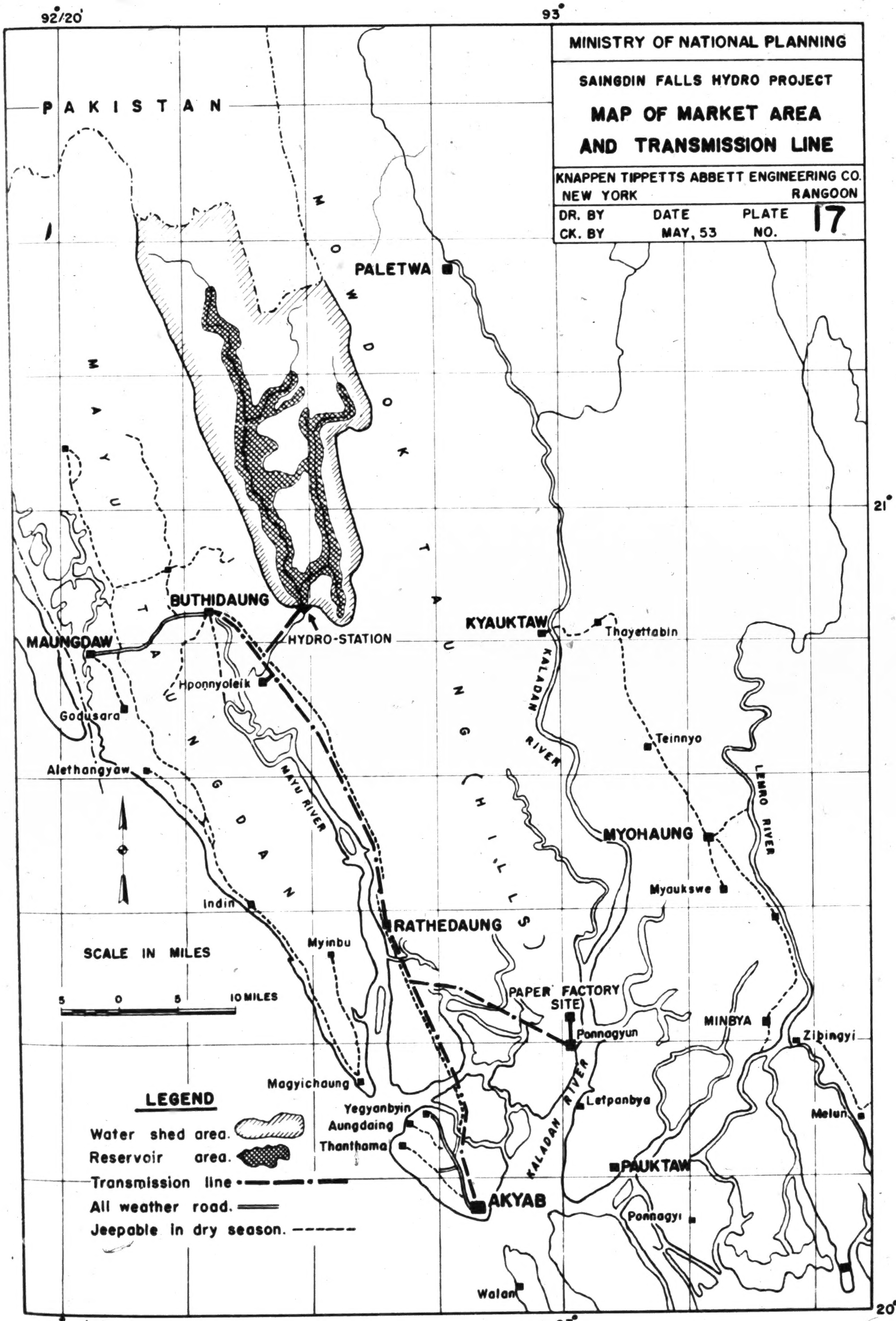
MINISTRY OF NATIONAL PLANNING

SAINGDIN FALLS HYDRO PROJECT

MAP OF MARKET AREA AND TRANSMISSION LINE

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY	DATE	PLATE	17
CK. BY	MAY, 53	NO.	


92°20'
93°
21°
20°
PAKISTAN
MOWDOK TAUNG (HILLS)
MAYU TAUNGDAN
PALETWA
BUTHIDAUNG
MAUNGDAW
HYDRO-STATION
Hponnyoleik
Godusara
Alethangyaw
Indin
Myinbu
RATHEDAUNG
MAYU RIVER
KYAUKTAW
Thayettabin
KALADAN RIVER
Teinnyo
LEMRO RIVER
MYOHAUNG
Myaukswe
PAPER FACTORY SITE
Ponnagyun
MINBYA
Zibingyi
Magyichaung
Yegyanbyin
Aungdaing
Thanthama
Letpanbya
KALADAN RIVER
PAUKTAW
AKYAB
Ponnagyi
Melun
Walan
SCALE IN MILES
5 0 5 10 MILES
LEGEND
Water shed area.
Reservoir area.
Transmission line
All weather road.
Jeepable in dry season.

The present and anticipated world demand including substantial needs within Burma assure an ample market for the output. Tenders for the design of the first installation have been received and a contract will be awarded in the near future for this work.

(2) Jute

Experimental cultivation of jute has been successful. Test bales have been sent to Japan for spinning and weaving in order to plan a burlap mill. It is probable that burlap bags can be economically produced in Akyab District and the expenditure of K.4,40,00,000 per year (1951 estimate) of foreign exchange for imported bags avoided. A project report has been submitted on the jute mill project.

(3) Brick and Tile

All roofing tile for Burma is imported. Common brick is of poor quality. Tiles can be produced in Akyab area and the quality of brick greatly improved in Government operated plants, saving foreign exchange and the necessity for stucco work on the exterior of the rough brick walls, now standard practice throughout Burma. It is probable that hollow wall tile can be produced to back up brick veneer or to construct lightweight partition walls. Salt glazed vitrified sewer pipe can be made in the same plant.

(4) Chemicals

Production of carbide, caustic soda, chlorine and other basic chemicals is under consideration by the Government. The establishment of such new industry is favored by the presence of raw materials, limestone and salt at Kyaukpyu with ocean haul of 100 miles to Akyab and low cost electric energy from Saingdin Falls. Substantial quantities of these products will be used by the welding operations, paper factories and fertilizer industry.

(5) Pumping

Dry weather irrigation and domestic water supply can be developed from the Saingdin reservoir, from natural ponds and old river channels located in the Mayu delta, and from wells. Pumping loads will become a major factor in the power system during the dry season. Pumps for drainage and for filling storage ponds during the wet season will tend to even up the annual load curve.

(6) Rubber

It is probable that rubber plantations can be developed successfully on the foothills adjacent to the rice and jute lands. It is understood that experimental plantations by the Government will be started in the near future.

g. Prospective Load

The principal power loads now anticipated for 1962 are summarized below:

ESTIMATED 1962 MAXIMUM DEMAND

No.	*Description*	*Demand in kW*
1.	Domestic	3,708
2.	Ice Plants, Port Mechanization, etc.	775
3.	Rice Mills	3,500
4.	Paper Factories	10,000
5.	Jute Bag Factories	800
6.	Brick and Roof Tile Plant	400
7.	Carbide Plant	1,500
8.	Pumping Loads	3,000
9.	Caustic Soda, Chlorine	2,600
10.	Paper Factory (Steam generation)	15,000
	Total Demand	41,283

For details of the above summary refer to Table XIX-22 (*see p. 612*) "Estimated Power Requirements, Akyab District".

h. Technical Details

(1) Rainfall

For five stations in the Akyab District and three stations in the Chittagong District (Pakistan) for the eyars 1901 to 1952 inclusive, the annual rainfall is shown in Table XIX-23 (*see p. 613*). The data were obtained from the Meteorological Department or from the Government of Pakistan through that Department. At Akyab the rainfall varied from a maximum of 323 inches in 1918 to a minimum of 135 inches in 1925. At Chittagong it varied from a maximum of 153 inches in 1927 to a minimum of 67 inches in 1907. The weighted average for the Saingdin Falls watershed varies from a maximum of 262 inches in 1918 to a minimum of 111 inches in 1933 (see Table XIX-25, *p. 615*). Theissen's method has been used to determine the weighted average when records of adjacent stations are available. For 1901–1906 and 1947–1952 it was necessary to construct a rainfall relation curve, Akyab vs. Saingdin watershed in order to approximate the rainfall over the watershed for those years. For 1939–1945 the rainfall over the watershed was approximated by a rainfall relation curve, Chittagong vs. Saingdin.

(2) Stream Flow

Daily gauge heights at Saingdin Falls have been recorded from May 1, 1952, to date. The gauge was installed and current meter measurements were made by experienced personnel of the Electricity Supply Board. A local village headman was employed to read and record the gauge heights. The stage-discharge curve is given on Plate 18. Based on the gauge readings and the discharge curve, an estimate of runoff for 1952 is given (Table XIX-24, *p. 614*) and the runoff factor is computed to be 55.7%.

TABLE XIX – 22

ESTIMATED POWER REQUIREMENTS, AKYAB DISTRICT

(Including the Paper Factory without Steam Generation)

	1951 (Actual)		*1957 (Estimated)*		*1962 (Estimated)*		*1967 (Estimated)*	
	Annual kWh/cap.	*Population*	*Annual kWh/cap.*	*Population*	*Annual kWh/cap.*	*Population*	*Annual kWh/cap.*	*Population*
Akyab	4·2	38,000	15	50,000	20	60,000	25	70,000
Buthidaung	—	—	10	15,000	15	25,000	20	35,000
Ponnagyun	—	—	15	10,000	20	20,000	20	25,000
Maungdaw	—	—	10	8,000	15	15,000	15	20,000
Rathedaung	—	—	10	7,000	15	10,000	15	20,000
Rural	—	800,000*	2	830,000	5	890,000	8	950,000
Totals		838,000		920,000		1,020,000		1,120,000

DOMESTIC POWER REQUIREMENTS

Location	*kW max. Demand*	*Load Factor*	*kWh per year Sales*	*kW max. Demand*	*Load Factor*	*kWh per year Sales*	*kW max. Demand*	*Load Factor*	*kWh per year Sales*	*kW max. Demand*	*Load Factor*	*kWh per year Sales*
Akyab	89	20	159,388	428	20	750,000	547	25	1,200,000	667	30	1,750,000
Buthidaung	—	—	—	114	15	150,000	214	20	375,000	320	25	700,000
Ponnagyun	—	—	—	86	20	150,000	183	25	400,000	229	25	500,000
Maungdaw	—	—	—	61	15	80,000	128	20	225,000	171	20	300,000
Rathedaung	—	—	—	53	15	70,000	86	20	150,000	171	20	300,000
Rural	—	—	—	1,265	15	1,660,000	2,550	20	4,450,000	4,330	20	7,600,000
Total Domestic				2,007		2,860,000	3,708		6,800,000	5,888		11,150,000
BULK POWER REQUIREMENTS												
Akyab Ice Plants	—	—	—	50	50	219,000	100	50	438,000	150	50	656,000
„ Cold Storage	—	—	—	75	60	394,000	150	60	788,000	250	60	1,310,000
„ Rice Mills	2,328†	—	—	2,500	30	6,560,000	3,500	30	9,190,000	4,500	30	1,1,800,000
Port Mechanization	—	—	—	110	20	193,000	250	20	436,000	500	20	438,000
Paper Factories	—	—	—	5,000	50	21,900,000	10,000	50	43,800,000	15,000	50	65,600,000
Jute Bag Factory	—	—	—	400	40	1,400,000	800	40	2,800,000	1,200	40	4,200,000
Brick and Roof Tile	—	—	—	200	40	700,000	400	40	1,400,000	600	40	2,100,000
Carbide Plant	—	—	—	700	50	3,060,000	1,500	50	6,600,000	2,500	50	10,900,000
Caustic Soda	—	—	—	1,300	50	5,690,000	2,600	50	11,400,000	4,000	50	17,500,000
Pumping Loads	—	—	—	1,500	25	3,280,000	3,000	25	6,600,000	4,500	25	9,800,000
Buthidaung Ice Plants	—	—	—	30	50	131,000	50	50	219,000	100	50	438,000
Ponnagyun Ice Plants	—	—	—	30	50	131,000	50	50	219,000	100	50	438,000
„ Docks	—	—	—	85	20	149,000	175	20	306,000	400	20	700,000
Total Bulk	—	—	—	11,980		43,807,000	22,575		84,196,000	33,800		125,880,000
Domestic	89	—	—	2,007		2,860,000	3,708		6,800,000	5,888		11,150,000
Bulk	2,328†	—	—	11,980		43,807,000	22,575		84,196,000	33,800		125,880,000
Grand Total	2,417	—	Incomplete	13,987		46,667,000	26,283		90,996,000	39,688		137,030,000
Max. Simultaneous Demand at Generators				13,000	41·0‡		25,000	41·5‡		37,000	42·3‡	
(Including the Paper Factory with Steam Generation)												
Domestic	89	20	159,388	2,007	—	2,860,000	3,708		6,800,000	5,888		11,150,000
Bulk	2,328	—	—	11,980	—	43,807,000	22,575		84,196,000	33,800		125,880,000
Paper Factory (Steam)	—	—	—	15,000	50	65,600,000	15,000		65,600,000	15,000		65,600,000
Grand Total	2,417	—	Incomplete	28,987		112,267,000	41,283		156,596,000	54,688		202,690,000§
Max. Simultaneous Demand at Generators				27,000	47·5‡		38,000	47·0‡		51,000	45·5‡	

* Estimated. † Based on 1941 Installations. ‡ System load factor.

§ Demand approaches capacity of hydro plant and estimated sales exceed available power supply, therefore paper factory electric boilers should be replaced with coal boilers about 1966.

TABLE XIX – 23

SAINGDIN FALLS PROJECT

Annual, Monthly Maximum, Daily Maximum Rainfall in Inches at Selected Stations

Year	Burma					Pakistan		
	Akyab	*Rathe-daung*	*Buthi-daung*	*Kyauk taw*	*Pal-etwa*	*Cox Bazaar*	*Chitta-gong*	*Lama*
1901	206·1	151·3	—	—	144·3	144·7	88·1	—
1902	189·0	192·1	—	—	125·6	160·5	124·5	—
1903	232·6	178·8	—	—	108·6	122·9	95·3	—
1904	187·4	190·0	—	—	136·9	134·7	95·7	—
1905	235·5	251·1	—	—	138·4	149·9	140·8	—
1906	176·8	165·9	158·7	—	140·9	136·6	101·4	—
1907	210·8	182·9	148·8	—	109·6	96·1	67·1	—
1908	204·7	140·8	133·7	—	118·5	133·4	95·3	—
1909	233·9	174·0	186·4	—	127·1	145·1	141·2	—
1910	217·9	173·7	147·2	—	103·7	100·6	98·6	—
1911	209·5	185·2	215·1	159·7	131·4	146·6	122·7	—
1912	235·8	264·8	158·8	133·3	111·3	131·1	103·5	—
1913	213·8	216·7	186·2	138·1	116·0	147·4	143·3	—
1914	236·3	143·4	202·0	154·8	137·8	137·9	110·3	—
1915	248·5	183·1	219·5	209·5	163·2	140·0	138·8	—
1916	269·0	156·5	206·9	101·5	126·6	150·7	114·8	114·3
1917	225·1	132·0	204·5	162·8	132·5	150·3	104·0	124·9
1918	323·5	148·0	329·7	262·0	199·4	217·6	125·5	126·4
1919	239·4	171·7	251·1	178·4	119·2	149·9	124·8	119·2
1920	224·5	200·8	226·3	139·2	104·7	137·2	87·9	110·7
1921	222·4	207·5	232·1	210·0	137·1	140·5	123·3	145·1
1922	233·9	197·8	225·7	114·1	120·3	124·4	78·2	106·7
1923	259·8	204·6	219·4	186·3	156·4	147·8	136·8	163·9
1924	252·6	202·7	210·9	189·8	150·0	164·2	133·1	116·4
1925	134·6	198·6	126·5	158·2	125·4	124·2	132·8	97·2
1926	245·1	205·9	192·4	184·5	162·0	158·4	121·3	133·7
1927	155·6	170·1	185·2	144·2	119·0	120·0	153·4	94·4
1928	203·4	169·6	199·2	146·1	125·8	103·6	109·8	104·4
1929	213·0	159·3	208·9	143·6	131·9	130·5	110·6	119·4
1930	197·1	148·4	156·6	143·8	122·1	139·4	90·5	101·1
1931	203·2	143·2	154·4	138·6	139·5	142·6	108·7	97·5
1932	185·1	163·0	156·4	178·8	140·1	140·7	117·5	110·5
1933	169·4	107·9	129·6	195·1	194·5	100·3	120·9	99·6
1934	168·8	153·1	143·6	161·1	147·5	142·5	117·0	123·1
1935	162·7	138·5	163·1	149·3	109·6	108·5	91·4	83·6
1936	159·2	177·4	165·3	166·6	133·2	143·3	104·0	139·8
1937	176·4	216·4	204·7	184·1	161·7	176·7	118·6	141·3
1938	215·4	191·2	173·3	137·9	123·8	151·7	122·9	120·6
1939						156·0	108·1	138·7
1940						148·2	123·0	125·1
1941						193·2	117·3	148·3
1942						154·1	97·5	111·5
1943						148·4	92·8	91·9
1944						116·5	94·0	89·4
1945						167·9	106·4	106·1
1946								
1947	205·3							
1948	241·8							
1949	181·2							
1950	177·3							
1951	208·3		131·1					
1952	217·5		164·5					
1953								
Average	211·5	177·6	186·2	160·4	130·7	141·7	112·3	116·8
Max. Month	62·1	77·7	71·2	81·7	53·6			
Max. Day	3·0	2·6	4·2	3·4	3·2			

(3) Regulated Flow

The annual rainfall data for 1901–1952 at Akyab and Saingdin watershed weighted average are given in Table XIX–25, together with the computed annual runoff based on a 50% runoff factor. The runoff modified by storage would have yielded a minimum of 1,430,000 acre feet per year. After deducting 40,000 acre feet for evaporation an average daily flow of 1,910 cusecs would have been maintained during the driest period of record, 1929–1947 inclusive, using 820,000 acre feet of reservoir capacity. As shown on the area capacity curve, Plate 19, the drawdown, spillway crest to minimum reservoir, would have been about 35 ft. in order to utilize the stored water. Plate 20 shows graphically the information given in Table XIX–25.

(4) Firm Power

Continuous firm power is computed as follows:

Pool Elev. 230 Tail Water Elev. 10 Gross Head 220 ft.

Av. Head $220-\frac{35}{2}=202{\cdot}5$ ft. Net Head (95%) $=192$ ft.

Continuous Power $1{,}910\times\frac{192}{15}=24{,}500$kW.

Initial Output 40,000 kW at 50% station capacity factor $20{,}000\times8760=175{,}000{,}000$ kWh at station $\cdot9\times175{,}000{,}000=157{,}000{,}000$kWh at load center.

Ultimate Output * 60,000 kW at 41% station capacity factor $24{,}500\times8760=214{,}000{,}000$ kWh at station $\cdot9\times214{,}000{,}000=192{,}000{,}000$ kWh at load center.

* A fourth unit of 20,000 kW may be added at some future date if justified by the water supply or capacity factor.

(5) Penstock Size

The normal maximum demand from three units will be 4,680 cusecs based on 60,000 kW ultimate installation, and 192 ft. average net head. For a 20-ft. diameter penstock the maximum velocity would be 14.9 ft. per sec. at average head, or 16.3 ft. per sec. at extreme low water for the 175 ft. minimum net head and 5,140 cusecs maximum demand. If a fourth unit should be installed the velocities would be increased 33% to 19.8 and 21·7 ft. per sec. respectively. It is concluded that the 20-ft. diameter penstock is a conservative selection based on present estimates of the size and type of market. It is in accordance with economic standards of design for short penstocks, which require 15 to 20-ft. per sec. velocity under the condition of normal head and output.

(6) Diversion Tunnel

The year 1952 produced peak flows of 19,000 cusecs in June and again in July. Rainfall for 1952 appears to have four-year frequency based on the "Rainfall Duration Curve," Plate 21, and can be

TABLE XIX – 24

SAINGDIN FALLS PROJECT

Rainfall and Runoff for Calendar Year 1952

	Jan.-Apr.	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
Rainfall*	2·79	19·14	36·35	66·44	41·43	28·98	18·77	3.63	Nil
Runoff†									
1	121 days @ 100 cusecs assumed low flow	430	1,820	5,860	17,060	3,570	2,550	2,180	1,280
2		430	1,530	5,400	7,820	3,250	1,820	2,780	1,170
3		430	1,530	3,000	11,235	3,250	1,530	1,400	1,280
4		430	1,680	3,000	15,605	3,000	1,400	1,680	1,170
5		430	1,680	4,600	14,630	3,000	1,060	1,820	1,170
6		730	1,680	3,000	13,660	3,000	2,350	2,000	1,060
7		730	1,680	2,350	12,205	6,360	2,000	2,350	1,060
8		620	2,000	2,180	10,265	5,000	1,680	1,680	940
9		730	1,530	10,750	10,750	4,200	1,820	1,400	430
10		520	1,280	8,300	12,205	4,200	2,000	1,280	430
11		520	1,170	3,250	8,300	9,770	5,860	2,350	430
12		340	1,680	3,570	4,600	3,860	5,400	2,780	430
13		250	2,550	3,860	3,250	7,820	4,600	2,000	430
14		160	2,180	8,300	2,180	3,860	3,860	1,680	430
15		80	1,680	7,350	6,360	2,350	2,350	1,530	430
16		830	3,570	4,200	3,860	4,200	2,780	1,280	430
17		620	2,550	3,860	3,860	2,550	2,350	1,060	430
18		430	3,570	3,000	3,860	2,180	1,680	1,400	430
19		340	2,780	3,860	3,860	2,180	1,530	1,280	430
20		250	1,680	3,250	3,250	3,000	1,280	1,060	430
21		340	2,000	2,780	3,000	9,770	1,400	940	430
22		1,170	1,820	3,250	2,550	9,770	1,170	830	430
23		1,060	1,280	4,600	1,680	8,300	940	1,170	430
24		1,060	1,400	13,175	1,400	5,860	730	1,060	430
25		830	1,530	12,205	2,780	8,780	1,680	940	430
26		830	4,600	13,660	9,270	6,840	2,780	940	430
27		830	5,860	15,120	16,575	3,860	2,550	830	430
28		1,170	6,000	18,515	13,660	3,250	2,350	830	430
29		1,060	6,000	19,000	7,820	2,780	2,550	730	430
30		1,820	19,000	13,660	6,000	3,570	2,000	730	430
31		3,000	—	17,545	5,000	—	1,680	—	430
	12,100	22,470	89,310	226,450	238,550	143,380	70,630	43,990	19,020

* 1952 Rainfall at Akyab 217·53 inches.

† 1952 Runoff, Saingdin Falls 865,900 day second feet.

Weighted Average Rainfall, Saingdin Watershed (based on Rainfall Relation Curve) 164·5 inches or 13·7 feet.

$$\therefore \text{Runoff Factor} = \frac{865{,}900 \times 2}{13{\cdot}7 \times 640 \times 354} = 55{\cdot}7\%$$

used as a basis for determining the capacity of the diversion tunnel. For a 25-ft. diameter concrete lined tunnel with a velocity of 40 ft. per sec. the diversion capacity would be 19,700 cusecs and with 50-ft. velocity, 24,500 cusecs. As to the Pegu plant, these velocities will be dependent on cofferdam pond levels at the time of a possible construction flood in the wet season, and construction schedules should provide for completion of the earth dam to a point above the danger level, during the dry season.

(7) Field Investigation

Seventeen diamond drill holes have been completed and the cores are available at the Electricity Supply Board, Rangoon Office. Core logs are on file at the following Government offices:

(*a*) Resident Engineer, Saingdin Falls
(*b*) Electricity Supply Board, Rangoon
(*c*) Geological Department, Rangoon
(*d*) Knappen Tippetts Abbett Engineering Co., Rangoon

TABLE XIX - 25

SAINGDIN FALLS PROJECT (354 sq. mi. Watershed)
Rainfall and Runoff for Calendar Years 1901–1952

Year	*Annual Rainfall*		*Thousand Acre Feet per Year*				*Net Cusecs Continuous*
	Akyab	*Saingdin*	*Inflow**	*Make up*	*Depletion*	*Yield†*	
1901	206·14	158	1,490	—	—	1,490	1,990
1902	189·03	146	1,380	50	50	1,430	1,910
1903	232·55	173	1,630	— 50	0	1,580	2,110
1904	187·37	145 ‡	1,370	60	60	1,430	1,910
1905	235·50	175	1,650	— 60	0	1,590	2,120
1906	176·79	149	1,410	20	20	1,430	1,910
1907	210·71	128·5	1,220	110	130	1,430	,,
1908	204·72	125·9	1,190	240	370	1,430	,,
1909	233·92	155·9	1,470	— 40	330	1,430	,,
1910	217·85	124·5	1,180	250	580	1,430	,,
1911	209·51	171·8	1,620	—190	390	1,430	,,
1912	235·80	134·5	1,270	160	550	1,430	,,
1913	213·83	150·0	1,420	10	560	1,430	,,
1914	236·29	169·2	1,600	— 170	390	1,430	,,
1915	248·51	190·0	1,800	— 370	20	1,430	,,
1916	269·02	165·5	1,560	— 20	0	1,540	2,060
1917	225·06	167·3	1,580	—	—	1,580	2,110
1918	323·48	262·5	2,390	—	—	2,390	3,220
1919	239·43	183·5	1,730	—	—	1,730	2,320
1920	224·53	163·5	1,540	—	—	1,540	2,060
1921	222·40	183·3	1,730	—	—	1,730	2,320
1922	233·93	170·9	1,610	—	—	1,610	2,160
1923	259·77	186·9	1,770	—	—	1,770	2,370
1924	252·55	178·5	1,690	—	—	1,690	2,260
1925	134·55	126·0	1,190	240	240	1,430	1,910
1926	245·06	176·5	1,670	—240	0	1,430	,,
1927	155·45	150·9	1,420	10	10	1,430	,,
1928	203·36	161·5	1,530	— 10	0	1,520	2,030
1929	212·98	169·0	1,600	—	—	1,600	2,140
1930	197·12	138·5	1,310	120	120	1,430	1,910
1931	203·22	146·0	1,380	50	170	1,430	,,
1932	185·07	147·5	1,390	40	210	1,430	,,
1933	169·40	111·3	1,050	380	590	1,430	,,
1934	168·82	145·0	1,370	60	650	1,430	,,
1935	162·74	135·2	1,280	150	800	1,430	,,
1936	159·20	148·9	1,410	20	820	1,430	,,
1937	176·38	182·5	1,720	—290	530	1,430	,,
1938	215·43	147·4	1,390	40	570	1,430	,,
1939	108·12	158	1,490	— 60	510	1,430	,,
1940	122·98	165	1,560	—130	380	1,430	,,
1941	117·28	162	1,530	—100	280	1,430	,,
1942	§ 97·54	152 ‖	1,440	— 10	270	1,430	,,
1943	92·77	150	1,420	10	280	1,430	,,
1944	93·76	151	1,420	10	290	1,430	,,
1945	106·45	157	1,480	— 50	240	1,430	,,
1946	—	—	—	—	—	1,430	,,
1947	205·33	157	1,480	— 50	190	1,430	1,910
1948	241·83	178	1,680	—190	0	1,490	1,990
1949	181·17	141	1,330	100	100	1,430	1,910
1950	177·25	138 ‡	1,300	130	230	1,430	1,910
1951	208·29	159	1,500	— 70	160	1,430	1,910
1952	217·53	164	1,630	—160	0	1,470	1,960

* Inflow based on 50% runoff factor.

† Including evaporation of 40,000 Ac. Ft./Yr.

‡ Proportioned from Akyab rainfall.

§ Chittagong rainfall.

‖ Proportioned from Chittagong rainfall.

A map showing the location and depth of the drill holes is in preparation for reference of above listed Government offices and for use in the detailed design of the structures. The map shows 5-ft. contours of the dam, power house, spillway and borrow pit areas.

The results of drilling indicate the presence of massive sandstone under the dam and power house area with hard blue shale in the tunnel site. The left abutment is deeply weathered and will require a deep cutoff trench and grouting to prevent seepage. The saddle spillway will be founded on hard shale at a depth of 60 ft. below ground surface.

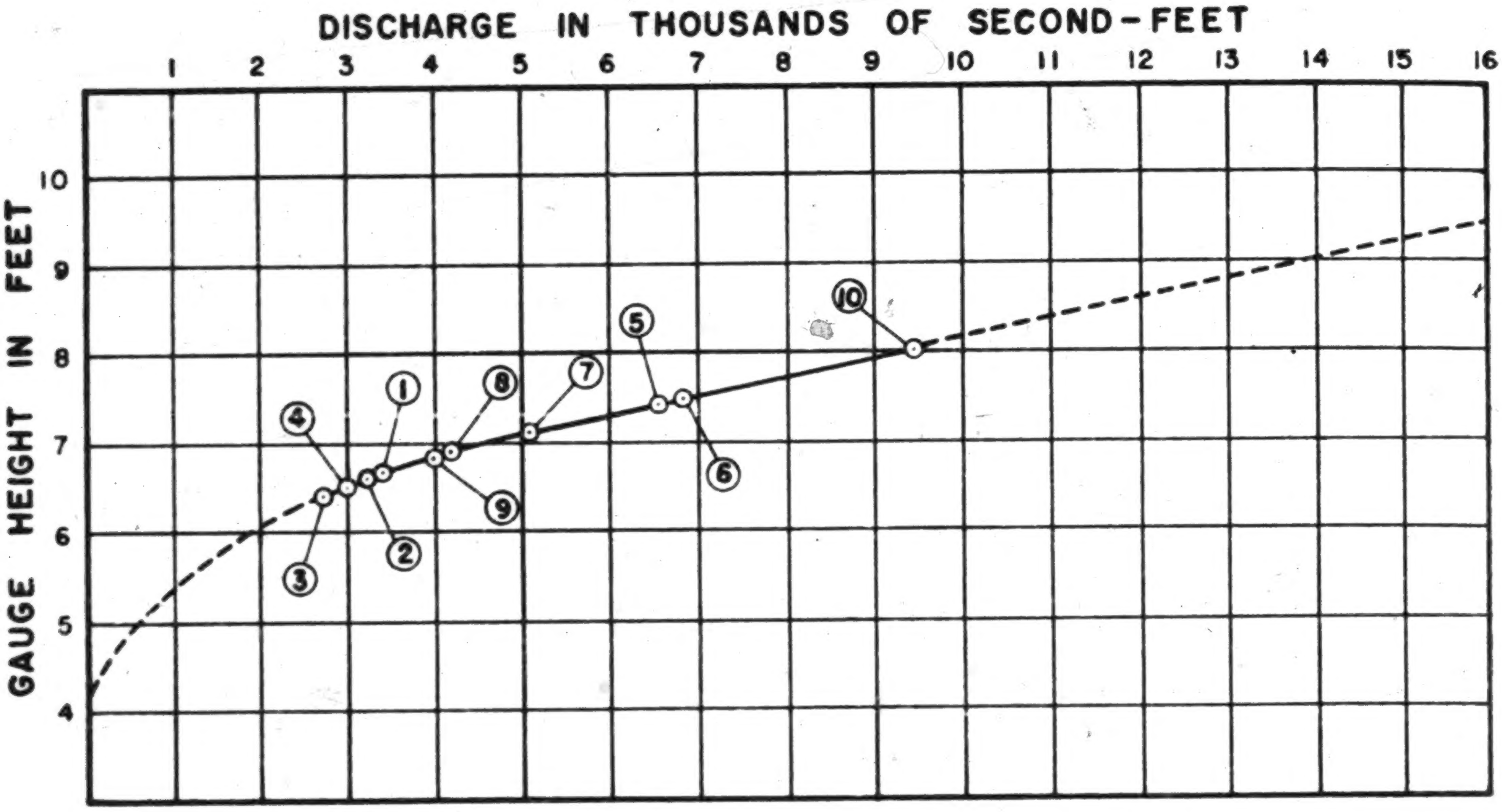
Ten test pits have been excavated in the borrow area (see Plate 22) indicating ample quantities of clay silt and shale for the earth dam. Samples and logs are available as for the core borings.

(8) Earth Dam

In view of the availability of earth fill materials and the long haul for suitable concrete aggregates, a rolled earth fill will be more economical than a concrete gravity dam. Other favorable factors are the existence of a natural saddle beyond the right abutment for economical spillway construction and the angling position of the falls which permits by-passing them with a short tunnel and a long tailrace channel in ledge rock below the falls. The rock from the tailrace excavation is suitable for slope protection on an earth dam, but not sufficiently durable for good concrete aggregates. The dam section has been estimated at one in three upstream slope, one in two downstream, with 30-ft. top width to accommodate an access road. The centre portion of the dam would be clay silt containing weathered shale from the borrow pit upstream of the tunnel intake. The zoning, riprap, cutoff and grouting procedures would closely resemble those recommended for the Pegu dam.

(9) Outlet Works

The left abutment location was chosen for the outlet works in order to by-pass the falls with a minimum length of tunnel and discharge channel (see Plate 22). The tunnel would be located in shale or sandstone, and its construction and that of the penstock would be similar to the Pegu construction. At the downstream end three lateral ten-foot diameter pipes would lead to three turbines in the powerhouse, each protected by a ten-foot diameter penstock valve. The 20-foot pipe would be reduced in stages to 10-feet in passing the laterals and the discharge end would be controlled by two ten-foot valves in tandem. The tunnel discharge channel would be concrete lined for 450 feet below the outlet portal.



NO.	DATE	GAUGE READING	DISCHARGE	RIVER STAGE
1	SEP 1 1952	6·68	3280	FALLING
2	” 2 ”	6·56	3100	STATIONARY
3	” 4 ”	6·48	2692	”
4	” 6 ”	6·49	3016	”
5	” 7 ”	7·43	6568	RISING
6	” 7 ”	7·50	6824	STATIONARY
7	” 8 ”	7·13	5068	FALLING
8	” 9 ”	6·89	4128	STATIONARY
9	” 9 ”	6·85	4020	FALLING
10	” 11 ”	8·08	9512	STATIONARY

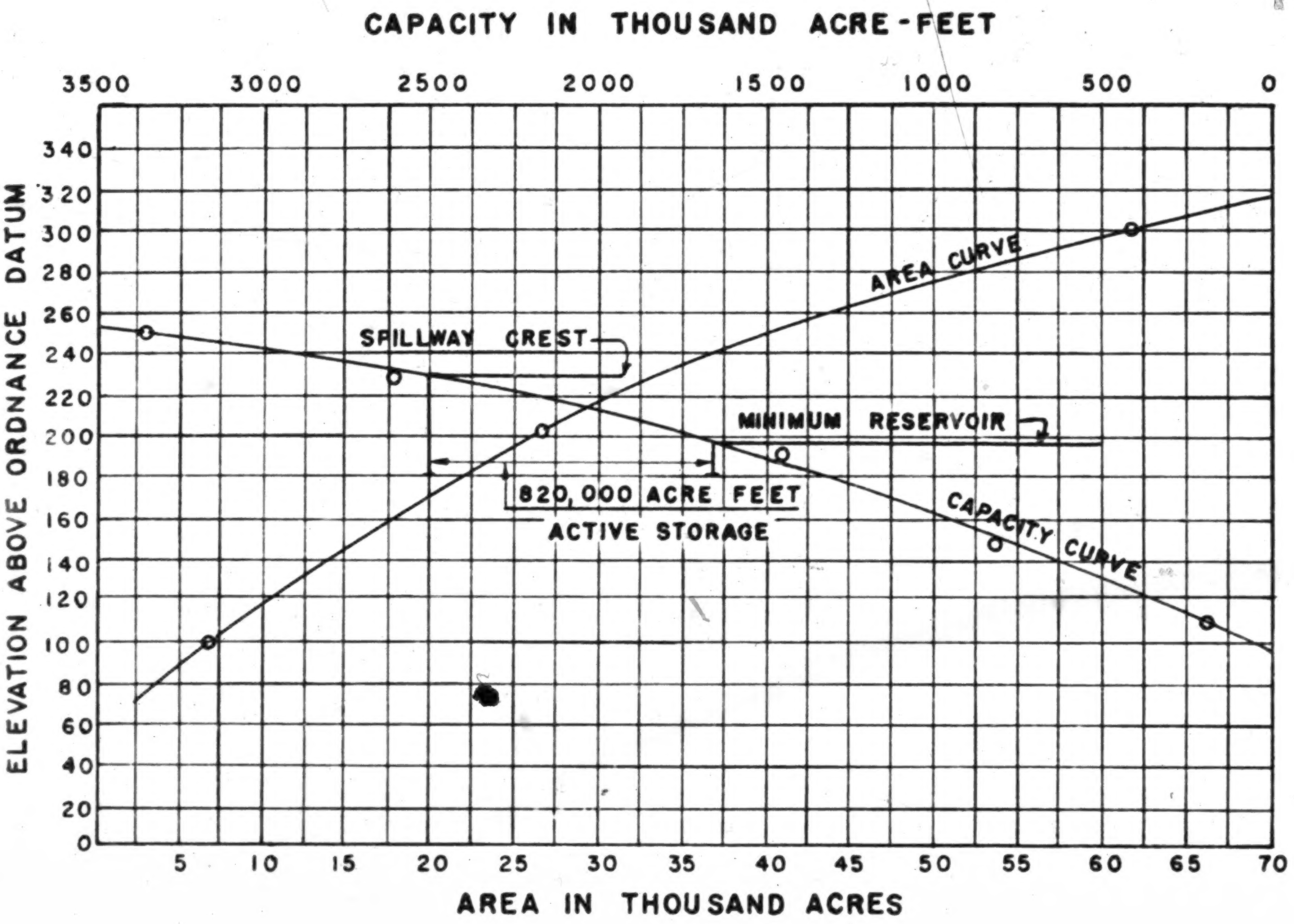
MINISTRY OF NATIONAL PLANNING

SAINGDIN FALLS HYDRO PROJECT
AKYAB DISTRICT

STAGE-DISCHARGE CURVE

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P. DATE MAY, 53 PLATE NO. 18
CK. BY GMT



MINISTRY OF NATIONAL PLANNING

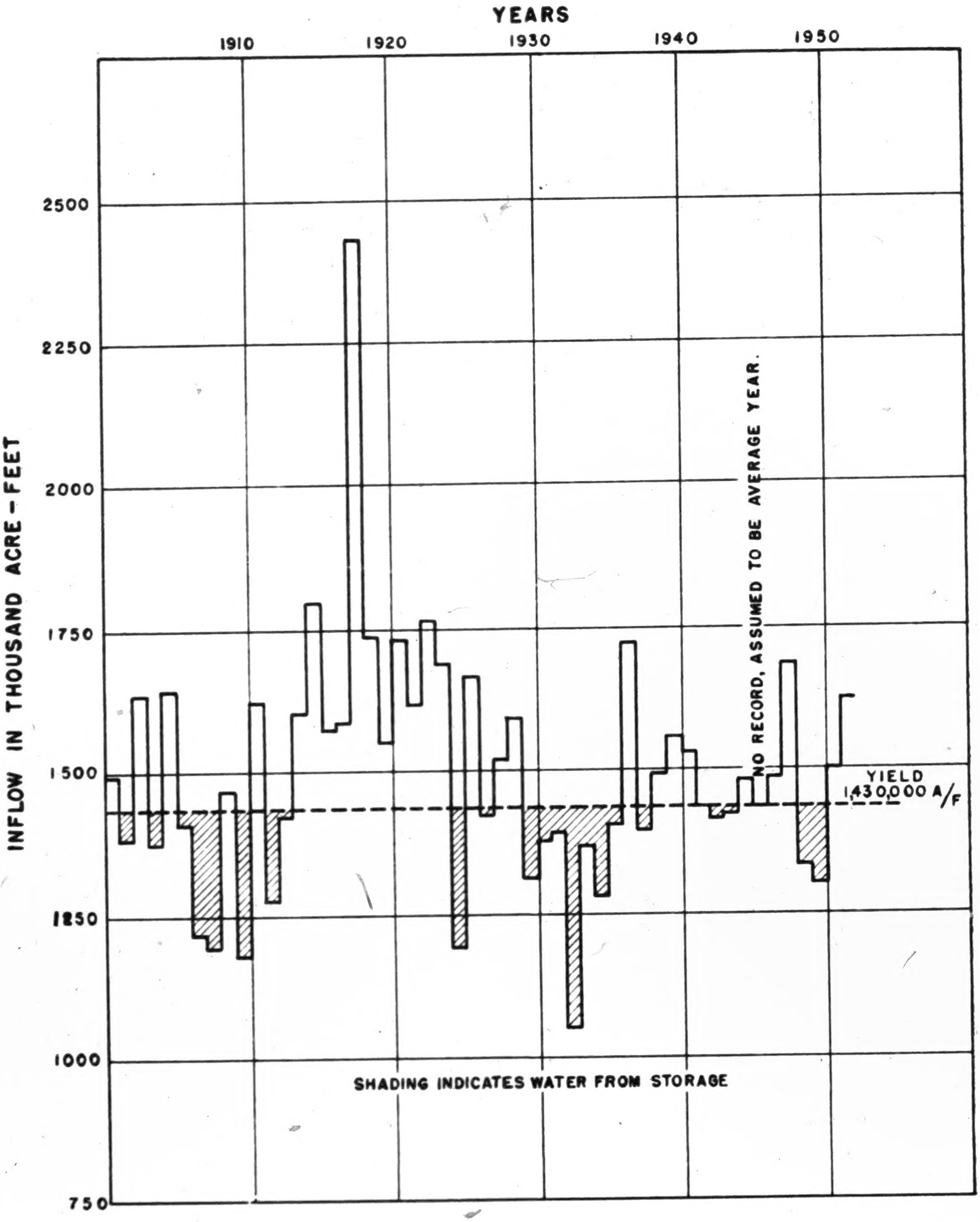
SAINGDIN FALLS HYDRO PROJECT

RESERVOIR

AREA-CAPACITY CURVE

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P. DATE PLATE
CK. BY. GMT MAY 53. NO. 19



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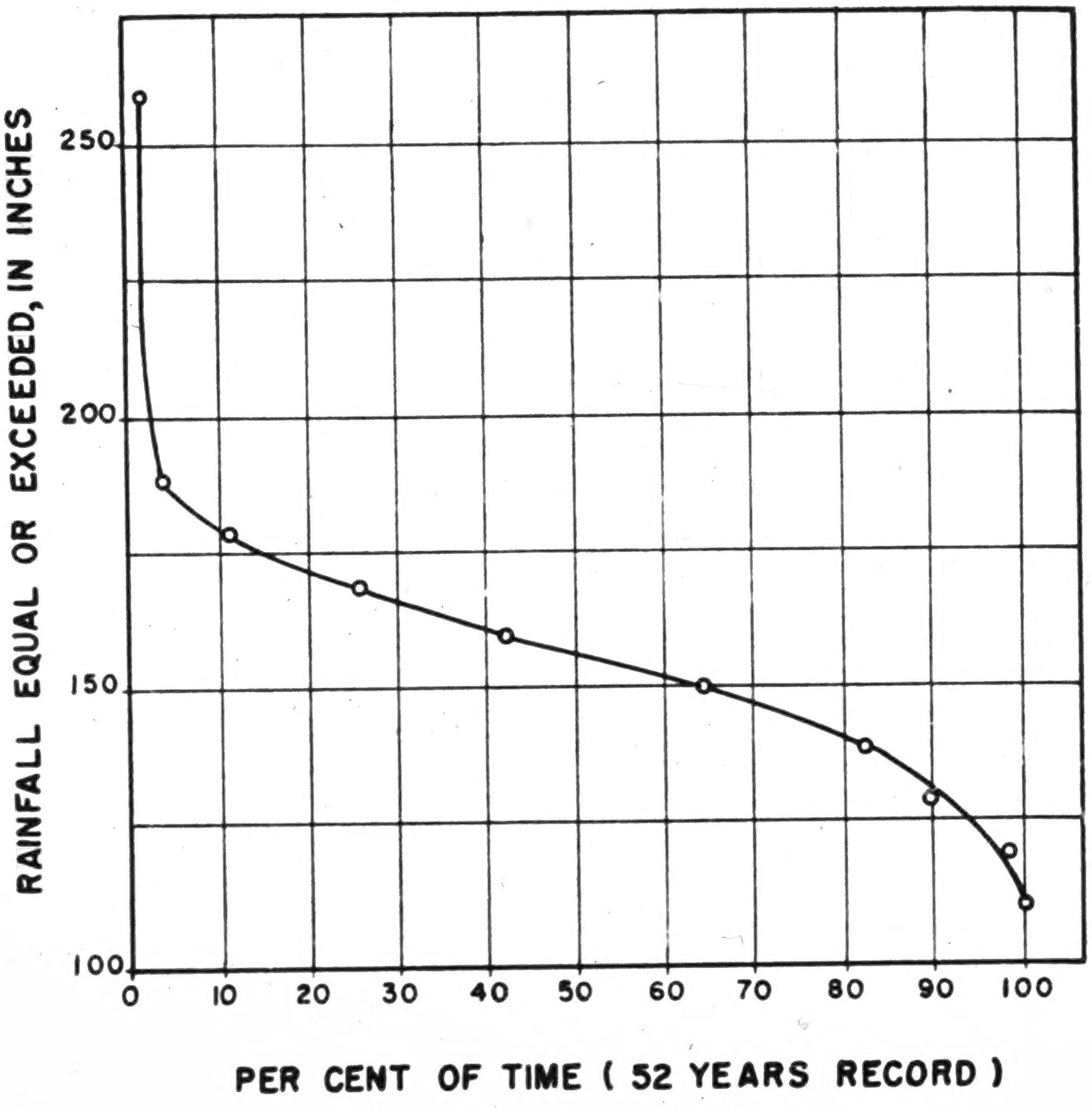
SAINGDIN FALLS HYDRO PROJECT

ANNUAL RUNOFF HYDROGRAPH

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. E.T.P. DATE
CK. BY. CMT MAY 53
PLATE NO 20



MINISTRY OF NATIONAL PLANNING

ANNUAL SAINGDIN
WEIGHTED AVERAGE

RAINFALL DURATION CURVE

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P. DATE PLATE
CK. BY GMT MAY 53. NO 21

(10) Spillway

About ¾ mile west of the dam site there is a natural saddle in which the spillway channel would be excavated as shown on Plates 22 and 23. There would be a concrete apron and slope paving at the control to prevent erosion and low flash boards to increase discharge at all stages during a spillway design flood. Analysis has been made of several hypothetical floods showing the dominant factor of surcharge storage in every case (see Plates 24 and 25, Flood Hydrographs and Mass Curves of Reservoir Inflow and Outflow). For the maximum assumption, 16·5 inches runoff in 24 hours and a peak flow of 12,000 times the square root of the drainage area, there will be over five feet of freeboard at maximum reservoir level, (top of dam, el. 245·0) assuming all turbines and sluice valves closed throughout the flood. After such a flood, 210 days would be required to empty the surcharge volume if turbines and valves remain closed, and 14 days if opened to release an average of 8,500 day second feet. The spillway channel outlet has a favorable location about 2½ miles downstream from the powerhouse and tailrace.

(11) Powerhouse

Two 28,000 horsepower-at-normal-head vertical Francis turbines directly connected to 20,000 kW water wheel generators would be provided initially. The power house substructure founded on rock below the falls would include the draft tube for a third unit of 20,000 kW, and in future could be extended to accommodate a fourth unit in line with the others supplied by a penstock from the ten-foot sluice valve. With 70 inches of rain in a month, indoor equipment is indicated. In other respects the powerhouse construction would closely resemble that planned for the Pegu project.

(12) Tailrace

To provide a low level outlet for powerhouse and sluice discharge, a long tailrace would be excavated in rock, as shown on Plate 22 having an estimated width of 75 ft. The width is subject to detailed economic study, comparing annual fixed charges with annual value of increased energy at 3·5 pyas per kWh. It should be noted that the tailrace excavation is the principal source of firm rock for riprap and slop protection on the dam. Therefore, the cost of increasing the width or depth will not be totally charged against the cost of increased energy, as long as the rock produced can be used advantageously in the dam.

(13) Substation

An outdoor substation would be provided with the main transformers located at the powerhouse and the switching structure on rock west of the outlet channel. The initial capacity would be 40,000 kW with layout to permit extension to add 20,000 kW in the future and possibly another 20,000 kW in the distant future. Voltage would be stepped up from 13·8 to 66 kV at the transformer bank. A double circuit 60,000 kW line would lead westward to supply Mayu Valley communities, the proposed paper factory and Akyab. A future 20,000 kW line would lead eastward to supply the Kaladan Valley.

(14) Transmission Line

Initial lines would consist of 66,000-volt 60,000-kW double circuit from the power station to a junction five miles south of Rathedaung, as shown on Plate 17. From the junction one 40,000-kW double circuit line would supply Ponnagyun and the proposed paper factory at Kyaukseik; and one 20,000 kW double circuit line would supply Akyab. Secondary lines would supply Buthidaung, by a 3,000-kW single circuit and Hponnyoleik with 1,000 kW. Future lines would extend from Buthidaung to Maungdaw and possibly from the power station eastward to the Kaladin Valley. The latter line would be located in rugged, jungle-covered terrain without existing access roads. All other lines would be adjacent to existing jeep roads or navigable water routes, in generally flat rice lands with no clearing required.

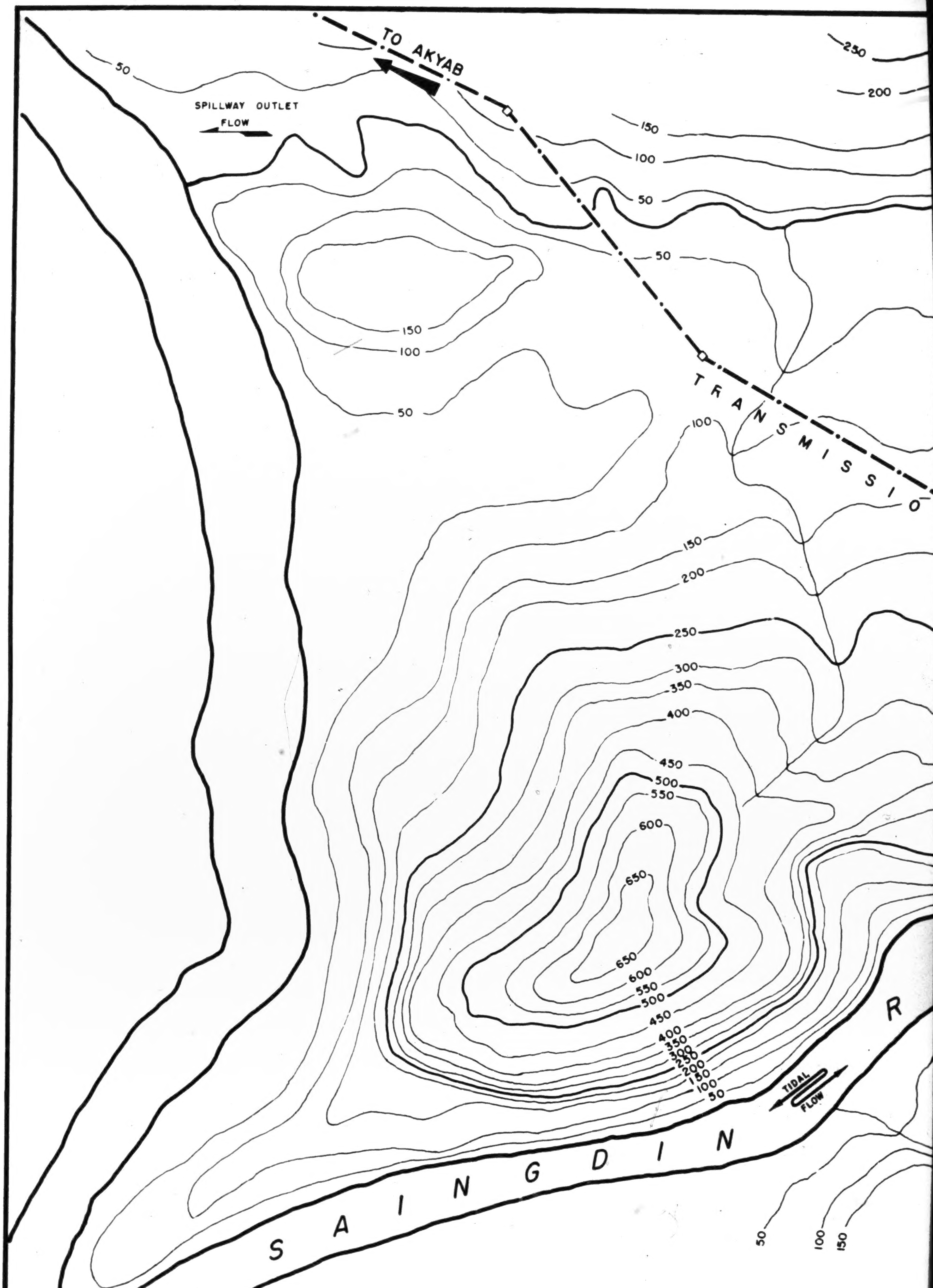
(15) Distribution System

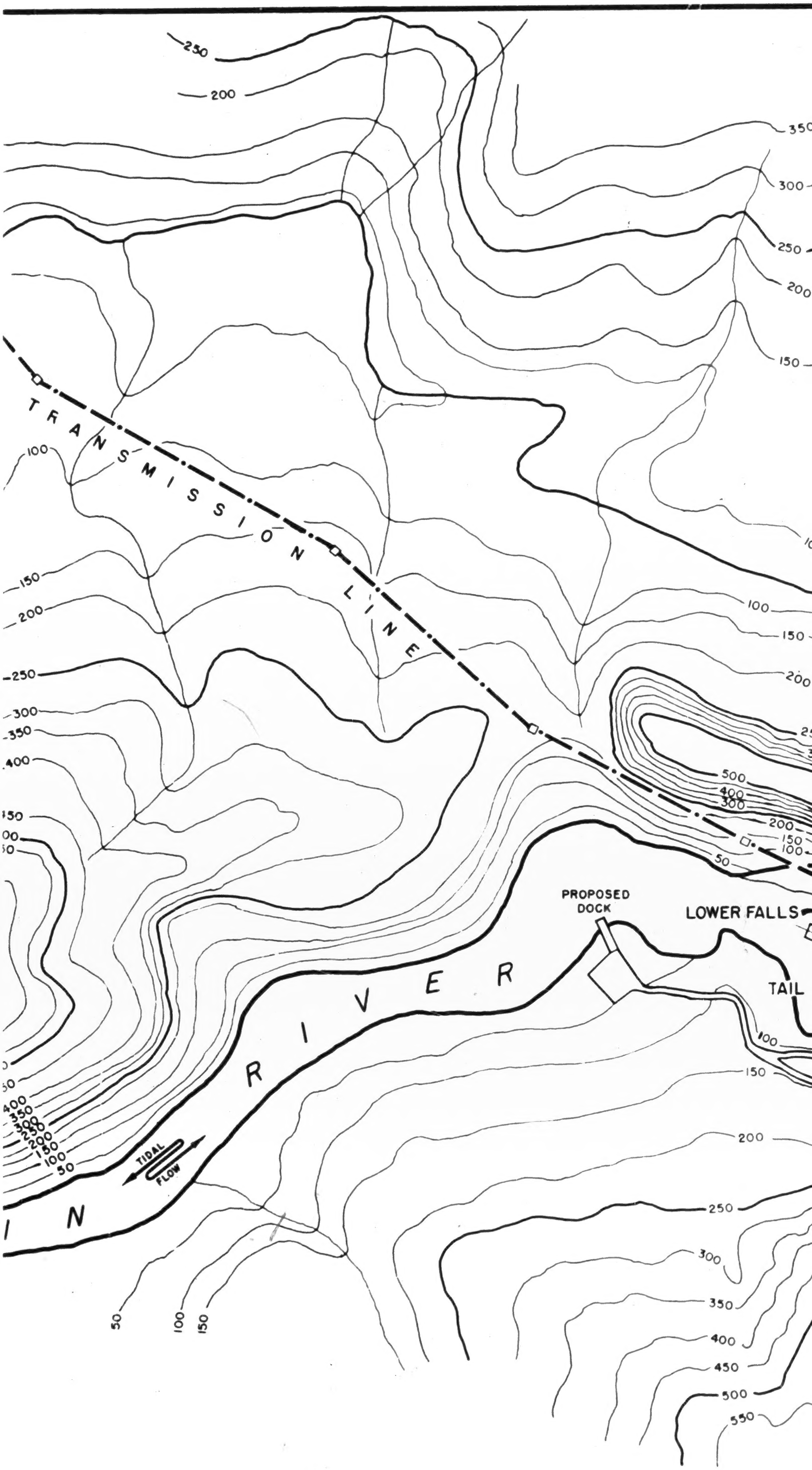
Details of the proposed distribution system must be determined after further field studies. Development, franchising and financing should be handled as recommended for the Pegu project.

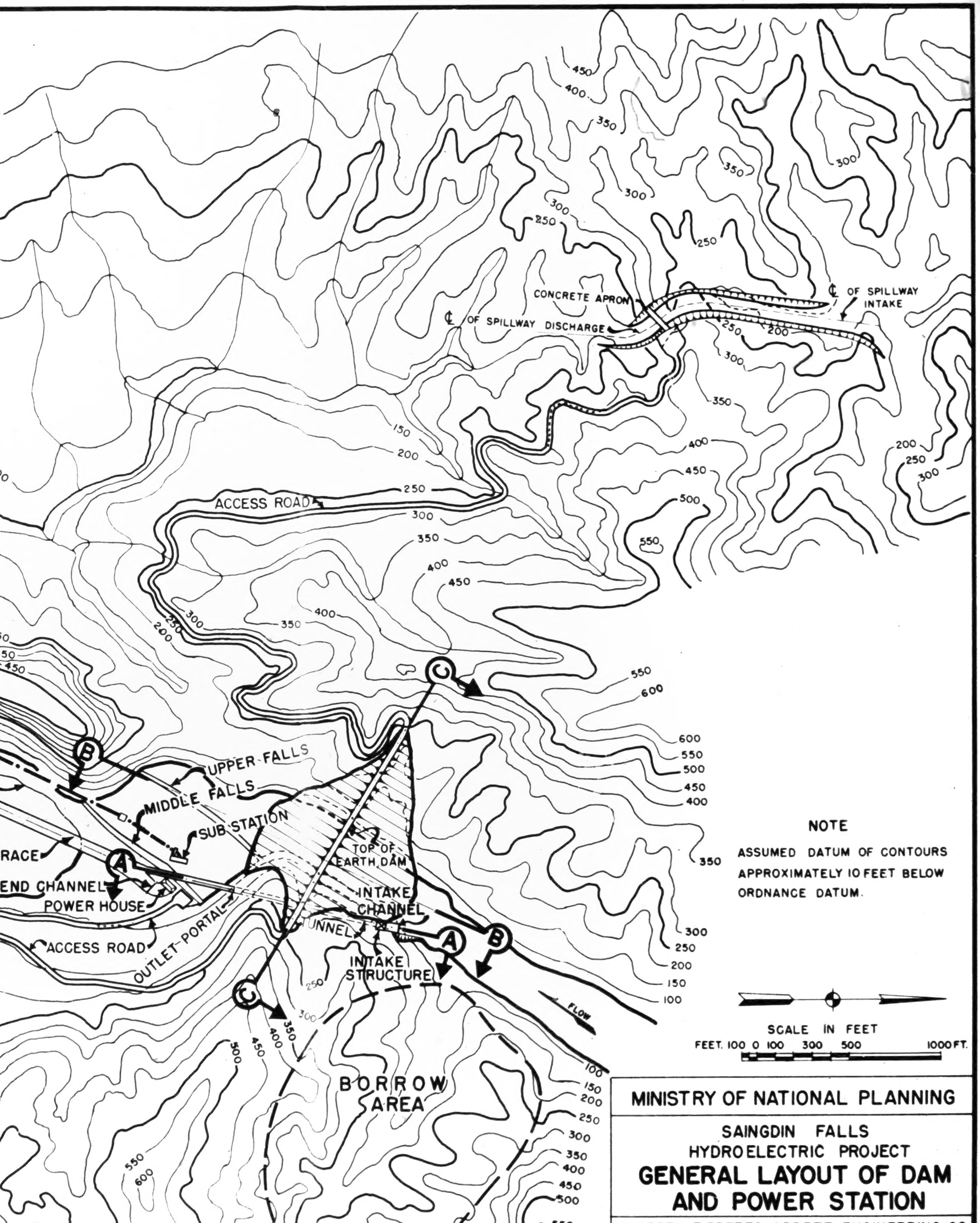
i. Construction Materials and Equipment

(1) Earth Fill

The borrow area for the earth dam would be located just upstream from the tunnel intake in the left abutment. It contains ample quantities of clay silt with fragments of weathered shale suitable for rolling into the impervious portion of the dam. The haul would be downhill for most of the material and the distance would vary from 1,000 to 2,000 ft. The construction of haul roads would not be difficult. A temporary bridge over the tunnel intake channel would be required.


TO AKYAB
SPILLWAY OUTLET
FLOW
TRANSMISSIO
SAINGDIN R
TIDAL FLOW
50
100
150
200
250
300
350
400
450
500
550
600
650


TRANSMISSION LINE
PROPOSED DOCK
LOWER FALLS
TAIL
IN RIVER
TIDAL FLOW
50
100
150
200
250
300
350
400
450
500
550


CONCRETE APRON
℄ OF SPILLWAY DISCHARGE
℄ OF SPILLWAY INTAKE
ACCESS ROAD
UPPER FALLS
MIDDLE FALLS
SUB STATION
RACE
END CHANNEL
POWER HOUSE
OUTLET PORTAL
ACCESS ROAD
TOP OF EARTH DAM
INTAKE CHANNEL
TUNNEL
INTAKE STRUCTURE
BORROW AREA
FLOW
A
B
C
450
400
350
300
250
200
150
100
500
550
600
SCALE IN FEET
FEET. 100 0 100 300 500 1000 FT.

NOTE

ASSUMED DATUM OF CONTOURS APPROXIMATELY 10 FEET BELOW ORDNANCE DATUM.

MINISTRY OF NATIONAL PLANNING

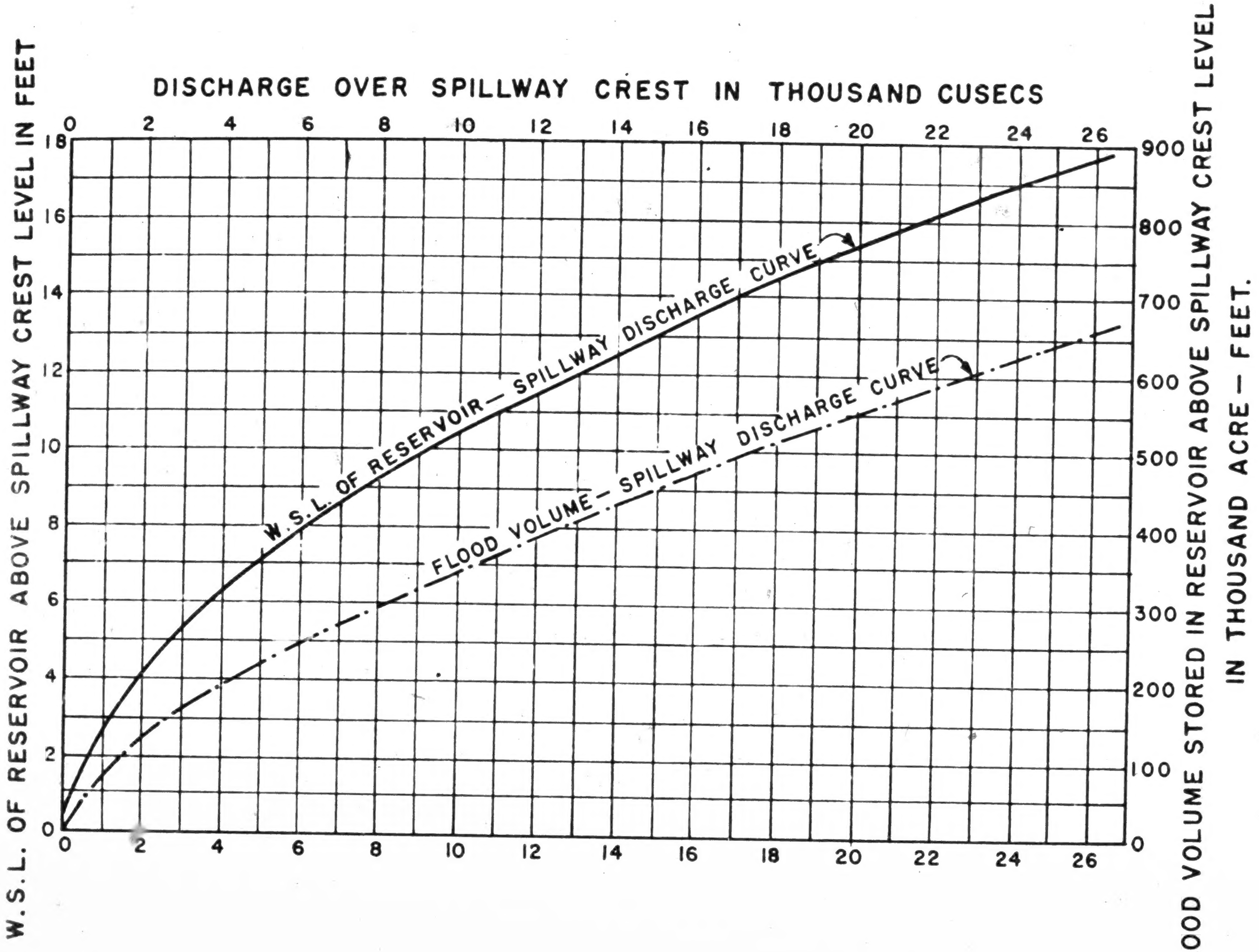
SAINGDIN FALLS
HYDROELECTRIC PROJECT

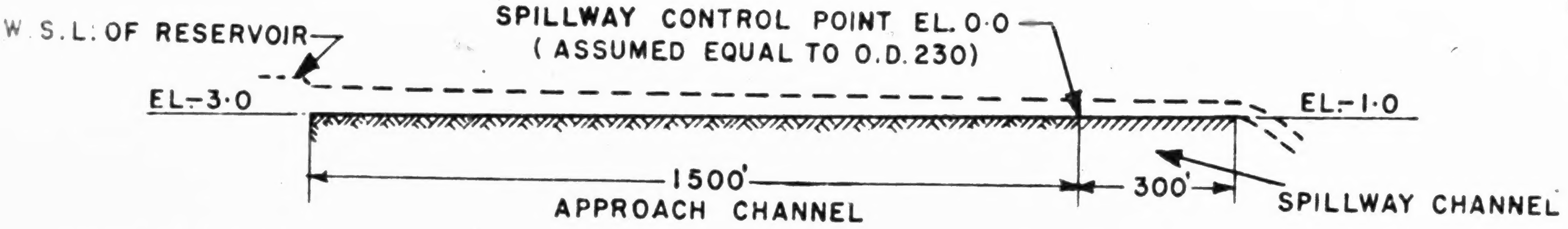
GENERAL LAYOUT OF DAM AND POWER STATION

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

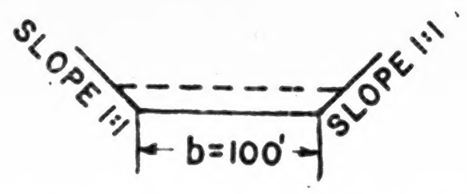
DR BY DATE
CK BY G.M. Tapley MAY, 53.

PLATE NO 22




W.S.L. OF RESERVOIR
SPILLWAY CONTROL POINT EL. 0·0
(ASSUMED EQUAL TO O.D. 230)
EL.-3·0
EL.-1·0
1500'
APPROACH CHANNEL
300'
SPILLWAY CHANNEL

SKETCH SHOWING LONGITUDINAL SECTION OF APPROACH & SPILLWAY CHANNEL


SLOPE 1:1
SLOPE 1:1
b=100'

SKETCH SHOWING C.S. OF SPILLWAY CHANNEL

MINISTRY OF NATIONAL PLANNING

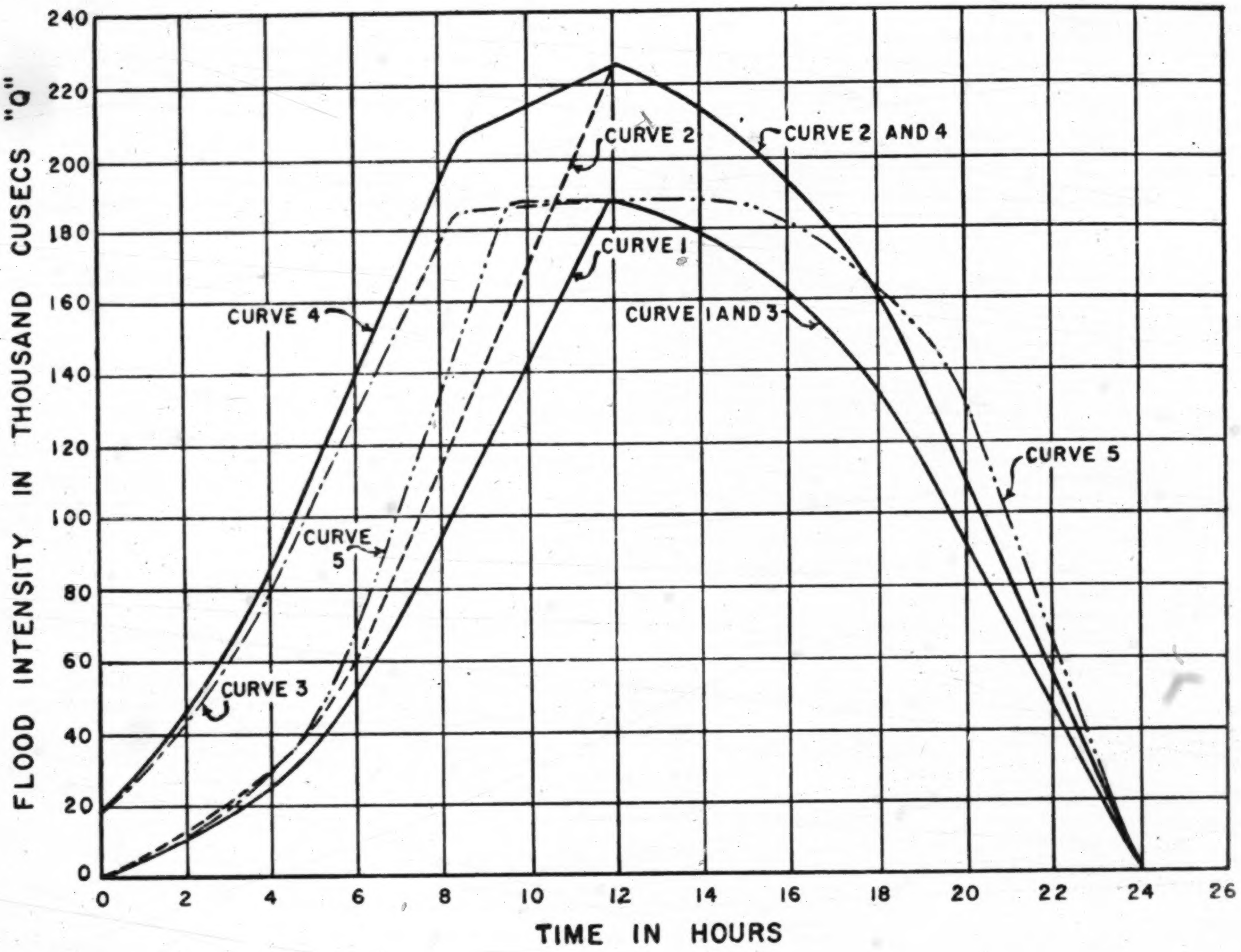
SAINGDIN FALLS HYDRO PROJECT

SECT'S & RATING CURVES

SADDLE SPILLWAY.

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. EJP	DATE	PLATE
CK. BY. GMT	MAY, 53.	NO. 23



CURVE 1. NORMAL HYDROGRAPH BASED ON PEAK INFLOW OF Qm= 10,000 $\sqrt{A}$ = 187,000 CUSECS AND PERIOD OF CONCENTRATION = 12 HOURS.

CURVE 2. NORMAL HYDROGRAPH MODIFIED FOR STORM WATER INFLOW OF PERIOD 24 HOURS AND VOLUME EQUIVALENT TO 12" RAINFALL ie, 9,750 X 10^6 CU.FT. OR 224,000 ACRE-FT WITH Qm= UNCONTROLLED.

CURVE 3. MODIFICATION OF NORMAL HYDROGRAPH FOR INITIAL FLOOD EQUIVALENT TO 10% OF MAIN FLOOD.

CURVE 4. HYDROGRAPH COVERING BOTH THE CONDITIONS OF CURVES 2 & 3 SIMULTANEOUSLY.

CURVE 5. NORMAL HYDROGRAPH CORRECTED TO STORM WATER INFLOW VOLUME OF 224,000 ACRE FT. IN 24 HOURS AND PEAK INTENSITY OF FLOOD LIMITED TO 187,000 CUSECS.

MINISTRY OF NATIONAL PLANNING

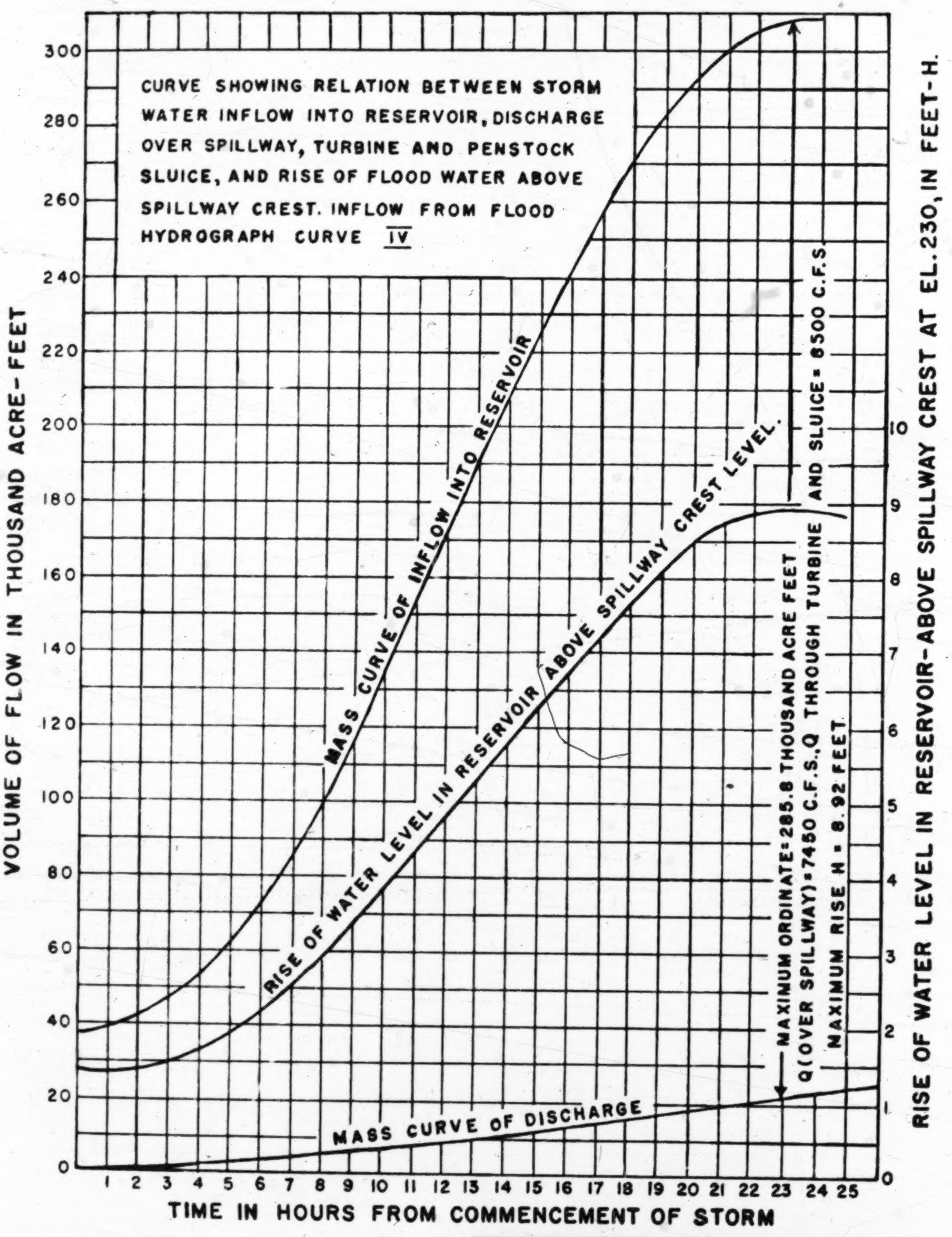
SAINGDIN FALLS HYDRO PROJECT

SPILLWAY DESIGN

FLOOD HYDROGRAPH

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON

DR BY EJP DATE PLATE
CK BY GMT MAY 53. NO **24**



MINISTRY OF NATIONAL PLANNING

SAINGDIN FALLS HYDRO PROJECT

MASS CURVE
INFLOW - OUTFLOW

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. EJP DATE PLATE
CK. BY. CMT MAY, 53 NO. **25**

(2) Gravel and Broken Stone

Pervious material to form the shells or filtering portions of the earth dam can be obtained from two sources: (*a*) rounded gravel from branch streams in very limited quantity and (*b*) shale outcrops on both abutments upstream or downstream from the dam. The latter should be the principal source of pervious material as the available quantity is large and the shale is resistant to disintegration if protected from drying. It should be mixed, graded, and zoned as for the Pegu dam.

j. Other Features

Slope protection, materials, equipment and procedure for contracting should also be handled as for the Pegu project. Quantities and costs based on considerations similar to those discussed for the Pegu project are given in Table XIX–26 "Estimated Costs—Initial Installation" (*see p. 625*).

k. Production Costs

The estimated annual costs of power at the load center are computed as follows:

Capital recovery with interest at 4·25%

Description	*Life in years*	*Factor*	*Investment* $	*Annual Cost* $
Electrical Controls	20	·0752	150,000	11,300
Generators, Portion of Substation	25	·0655	1,600,000	104,800
Turbines, Butterfly Valves, Trash Racks	35	·0555	1,630,000	90,500
Transmission Line	35	·0555	1,620,000	90,000
Civil Engineering Works Building	50	·0491	11,080,000	543,000
Operation and Maintenance		·0127	16,080,000	204,000
Annual Cost, Initial Development (6·5%)				1,043,600

Note: Interest has been assumed at 4% for 75% of total investment and 5% for the remainder.

Cost per kWh at Load Center (Initial Development)

	kWh	*Mills*	*Pyas*
Total power (see para. 3–h–(4))	157,000,000	6·67	3·18
Est. sales 1957 (Table XIX–22 corrected for output at load center)	129,000,000	8·11	3·86
67% of total	105,000,000	9·95	4·74

Ultimate development 6·5% × 21,280,000 = $1,380,000

Cost per kWh at Load Center (Ultimate Development)

	kWh	*Mills*	*Pyas*
Total power (see para. 3–h–(4))	192,000,000	7·20	3·43

The foregoing cost comparison is based on firm power computed for the minimum years of record and on capacity factors which can be attained with the installation of the paper factory and other industrial loads now available or in the planning stage. Secondary power is small and has been neglected in the economic analysis presented above. The value of power for design of pipe line, tailrace and other hydraulic features will be taken at 3·5 pyas per kWh.

l. Distribution Costs

It is believed that 8 pyas (1·68 cents) per kWh is an ample allowance for the distribution costs of a new system containing about 10% domestic load as given in Table XIX–22 for 1957. The allowance has been reduced to 7·5 pyas for 1962 and 7·0 pyas for 1967, when loads should be greater and system inefficiencies reduced. The annual cost for 1957 and the initial investment are computed as follows:

	kWh per year		*Pyas*	*Kyats*
Domestic and Bulk Sales	46,667,000	@	8·0 =	37,40,000
Paper Factory (Process Steam)	65,600,000	@	0.4 =	2,62,000
Annual Cost, 1957				K40,02,000

Capitalized at 12%.

Investment K3,38,00,000* ($7,100,000) for initial Development.

Capital recovery with interest at 4·25%.

Amortization factor—20-year life	·075
Operation and maintenance	·045
Total annual cost	·120

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*Of this sum K21,00,000 or $442,000 will be provided under the initial diesel program for the Akyab distribution system.

m. Electric Rates

The proposed electric rates in Table XIX–27 (*see p. 626*) range from 60 pyas per kWh rural (villages of 1,000–5,000 population) to 50 pyas, urban (towns of 5,000 to 50,000 population) in 1957. It is estimated that these rates can be reduced to 40 and 30 pyas respectively by 1967. The present rates are 100 pyas (urban) from the small government-operated diesel plant. No rural supply exists. Small industrial enterprises such as rice mills, pumping plants, and port mechanization would receive a rate of 25 pyas initially and 15 pyas in the future. Large industrial projects, the paper factories, carbide plant, etc., would receive a rate of 15 pyas initially and 10 pyas in the future. Otherwise rates should be established by the Government rate board as recommended for the preceding projects.

n. Conclusion

Ownership and operation should be handled as recommended for the preceding projects. As this project appears feasible in all respects, it too is recommended for immediate detailed investigation, design and construction, with construction to be completed by the end of 1957 in time to supply the new pulp and paper factory.

TABLE XIX – 26

SAINGDIN FALLS HYDROELECTRIC PROJECT
ESTIMATED COST—INITIAL INSTALLATION
(US Dollars)

No.	*Description*	*Quantity*	*Unit*	*Unit Cost*	*Cost*	*Percentage*		
						Local	*Sterling*	*US*
				$	$			
1	Exploration and design	l.s.	—	—	650,000	20	—	80
2	Clearing reservoir	10,000	ac.	50·00	500,000	80	10	10
3	Clear and grub dam site	40,000	s.y.	1·00	40,000	80	10	10
4	,, ,, ,, borrow area	60,000	s.y.	0·50	30,000	80	10	10
5	,, ,, ,, spillway	20,000	s.y.	1·00	20,000	80	10	10
6	,, ,, ,, town site	40,000	s.y.	0·50	20,000	80	10	10
7	Access roads	4	mi.	10,000	40,000	70	20	10
8	Excavation, cutoff trench	7,000	c.y.	4·00	28,000	70	10	20
9	,, tunnel portal	55,000	c.y.	3·00	165,000	70	10	20
10	,, tailrace	140,000	c.y.	3·00	420,000	70	10	20
11	,, power house	44,000	c.y.	5·00	220,000	70	10	20
12	,, spillway	400,000	c.y.	1·00	400,000	70	—	30
13	,, borrow pit	2,500,000	c.y.	0·60	1,500,000	70	—	30
14	Cofferdam and diversion	l.s.	—	—	200,000	70	—	30
15	Foundation, preparation dam	30,000	s.y.	2·00	60,000	70	—	30
16	Drilling holes for grout	50,000	l.f.	1·00	50,000	60	—	40
17	Grouting cutoff and tunnel	100,000	c.f.	2·00	200,000	60	—	40
18	Placing and rolling earth fill	2,300,000	c.y.	0·16	368,000	60	—	40
19	Excavation, tunnel	16,500	c.y.	10·00	165,000	60	—	40
20	Concrete, tunnel lining	4,200	c.y.	60·00	252,000	60	—	40
21	,, portals and channel	18,500	c.y.	32·00	592,000	60	—	40
22	,, intake tower	8,600	c.y.	40·00	344,000	60	—	40
23	,, spillway	15,000	c.y.	32·00	480,000	60	—	40
24	,, power house substruct.	7,500	c.y.	48·00	360,000	50	—	50
25	,, retaining wall	2,400	c.y.	40·00	96,000	60	—	40
26	Reinforcing steel	3,000,000	lbs.	0·10	300,000	40	50	10
27	Penstock steel	3,200,000	lbs.	0·25	800,000	40	50	10
28	Trash racks and frames	400,000	lbs.	0·25	100,000	40	50	10
29	Head gates, frames, hoists	360,000	lbs.	0·50	180,000	40	50	10
30	Gate house and bridge	l.s.	—	—	30,000	50	40	10
31	Hydraulic machinery	56,000	h.p.	20·00	1,120,000	20	—	80
32	Electrical machinery	40,000	kW	30·00	1,200,000	20	—	80
33	Additional butterfly valves	2	each	50,000	100,000	20	—	80
34	Electrical controls	l.s.	—	—	120,000	20	—	80
35	Substation complete	l.s.	—	—	300,000	20	—	80
36	Power house superstructure	250,000	c.f.	1·00	250,000	60	30	10
37	Crane complete	l.s.	—	—	90,000	20	60	20
38	Living quarters	l.s.	—	—	300,000	40	50	10
39	Transmission Line	56	mi.	15,000	840,000	50	30	20
40	,, ,,	29	mi.	10,000	290,000	50	30	20
41	,, ,,	30	mi.	6,000	180,000	50	30	20
	Subtotal				13,400,000			
42	Engineering and Contingencies 20%				2,680,000			
	Total Hydro plant and transmission system				16,080,000	48·4	11·3	40·3
43	Distribution system				6,658,000	50	30	20
	Total including dist. system				22,738,000			

TABLE XIX – 27

ESTIMATED INCOME AND COST OF ENERGY—AKYAB DISTRICT
(Including Paper Factory with and without the Steam Generation Load)

	1957		*1962*		*1967*	
Hydro Capacity kW	40,000		60,000		60,000	
Annual Revenue	*Est. Rate Pyas per kWh*	*Annual Revenue Kyats*	*Est. Rate Pyas per kWh*	*Annual Revenue, Kyats*	*Est. Rate Pyas per kWh*	*Annual Revenue, Kyats*
Domestic, Urban	50	6,00,000	40	9,40,000	30	10,63,000
,, Rural	60	9,95,000	50	22,20,000	40	30,40,000
Bulk, Rice Mills	25	16,40,000	20	18,40,000	15	17,70,000
,, Paper Factories	15	32,90,000	12	52,60,000	10	65,60,000
,, Carbide Plant	15	4,60,000	12	7,92,000	10	10,90,000
,, Caustic Soda	15	8,40,000	12	13,70,000	10	17,50,000
,, Pumping	25	8,20,000	20	13,20,000	15	14,70,000
,, Other	25	8,30,000	20	13,20,000	15	15,40,000
Total excl. Steam Generation		94,75,000		1,50,62,000		1,82,83,000
Steam Generation	2·5	16,40,000	2·5	16,40,000	2·5	16,40,000
Total including Steam Generation		1,11,15,000		1,67,02,000		1,99,23,000
Annual Operating Costs						
Power Plant (6·5%)		50,20,000		62,00,000		66,30,000
Distribution System	8·0	37,40,000	7·5	68,20,000	7·0	95,80,000
Total Annual Cost						
Without Steam Generation		87,60,000		130,20,000		162,10,000
Net Profit—Steam Generation		7,15,000		20,42,000		20,73,000
Dist. System added for Steam Gen.	0·4	2,62,000	0·4	2,62,000	0·4	2,62,000
Total Annual Costs						
With Steam Generation		90,22,000		1,32,82,000		1,64,72,000
Net Profit—Steam Generation		20,93,000		34,20,000		34,51,000

F. KALEWA MINE POWER PROJECT

1. DESCRIPTION

A preliminary study has been made of the power requirements at the proposed Kalewa mine and adjacent communities. The estimated population, domestic and bulk demand, and sales, are given in Table XIX–28 (*see p. 327*), and summarized as follows:

	1957	*1962*	*1967*
Max. demand at generators, kW	3,600	4,200	5,000
Estimated sales in kWh	13,224,000	15,449,000	17,819,000

The requirements for the mine have been taken from the Kalewa Coal Project Report dated April 1953. Other bulk requirements are proportioned from existing markets at Rangoon and Mandalay. The estimated domestic sales are based on per capita use at other small communities in Burma. In order to provide moderate spare capacity it is concluded that the initial installation should consist of three 2,000-kW generators. Substation and 33-kV transmission lines to Kalemyo and Mawlaik should be provided to bring low cost power to the principal towns of the Upper Chindwin. The estimated cost is here summarized:

	1957	*1962*	*1967*
Generating Capacity in kW	6,000	6,000	8,000
Estimated Cost of Power Station	$1,575,000*	$1,840,000*	$2,080,000*
Estimated Cost of Transmission Lines	330,000	440,000	550,000
Total Cost	$1,905,000	$2,280,000	$2,630,000

Of the amounts indicated by (*) $1,575,000 are included in the Kalewa Coal Project Report for the mine power plant. The same plant will supply the mine city and adjacent communities as distant as Mawlaik, 35 miles to the north.

TABLE XIX – 28

KALEWA COAL MINE AND ADJACENT AREA—ESTIMATED POWER REQUIREMENTS

Domestic (Per Capita Use)	*1957*		*1962*		*1967*	
	Annual kWh/cap.	*Population*	*Annual kWh/cap.*	*Population*	*Annual kWh/cap.*	*Population*
Mine City	15	10,000	20	12,000	25	15,000
Kalemyo	10	3,000	15	4,000	20	5,000
Zinaung	10	2,000	12	2,500	15	3,000
Kalewa	10	1,000	12	1,500	15	2,000
Mawlaik	10	3,000	15	4,000	20	5,000
Rural	2	30,000	5	40,000	8	50,000

	1957			*1962*			*1967*		
	kW Max. Demand	*Load Factor*	*Thous. kWh per year Sales*	*kW Max. Demand*	*Load Factor*	*Thous. kWh per year Sales*	*kW Max. Demand*	*Load Factor*	*Thous. kWh per year Sales*
Domestic Power Requirements									
Mine City	86	20	150	110	25	240	194	25	375
Kalemyo	23	15	30	34	20	60	57	20	100
Zinaung	15	15	20	23	15	30	26	20	45
Kalewa	8	15	10	14	15	18	23	15	30
Mawlaik	17	20	30	27	25	60	46	25	100
Rural	46	15	60	152	15	200	304	15	400
Total Domestic	195		300	360		608	650		1,050
Bulk Power Requirements									
Mine City Ice	30	60	158	40	60	210	50	60	262
Pumping Stations	50	30	131	60	30	158	75	30	197
Military Post	10	40	35	15	40	53	20	40	70
Mining Operations	3,500	40	12,250	4,000	40	14,000	4,500	40	15,750
Processing Plant	50	80	350	60	80	420	70	80	490
Total Bulk	3,640		12,924	4,175		14,841	4,715		16,769
Bulk and Domestic	3,835		13,224	4,535		15,449	5,365		17,819
Max. Simultaneous Demand at Generators	3,600	42*		4,200	42*		5,000	41*	

* System load factor.

2. PRODUCTION COSTS

The estimated annual cost at the load center is computed as follows:

Capital Recovery with Interest at 4·25%

Item	*Life in years*	*Factor*	*Investment* $	*Annual Cost* $
Boilers and Electrical Controls	20	·0752	460,000	34,600
Steam Turbines	22	·0714	500,000	35,700
Transmission Lines	35	·0555	330,000	18,300
Civil Eng. Works Buildings	50	·0491	615,000	30,200
Capital Recovery Charges				118,800

Item	*Annual Cost*
Labor Cost	27,000
Supplies, Repairs, Contingencies	10,000
Transmission Line Maintenance (1·5% of Trans. Line Costs)	5,000
Fuel Cost (1957 market) $\frac{25\cdot0\times1\cdot25\times13{,}224{,}000\times1\cdot3}{4\cdot75\times2{,}240}$ =	50,500
Total Annual Cost	211,300

Cost per kWh at the load center (1957)
$211{,}300\div(13{,}224{,}000\times1\cdot15)=13\cdot9$ mills or 6·64 pyas

3. CONCLUSION

The power requirements estimated in Table XIX–28 lead to the recommendations that a 6,000-kilowatt steam plant be installed at the mine, and that transmission lines be provided to Kalemyo and Mawlaik with service to intermediate communities. Domestic rates should start at Ps 50 per kWh by 1957, and can be reduced to Ps 30 per kWh by 1967 if the anticipated load growth is realized. Ice plants, pumping, and small industrial consumers should receive a rate of Ps 25 per kWh, reducing to Ps 15 by 1967. The mine rate for bulk power should be Ps 8·0 per kWh reducing to Ps 6·0 by 1967.

G. OTHER HYDROELECTRIC PROJECTS FOR FUTURE DEVELOPMENT

1. PAUNGLAUNG RIVER PROJECT

a. Description

A near future project recommended for completion in 1960 is the Paunglaung River Hydroelectric Station near Pyinmana (see Plate 1). Since the cost per kWh at load center is low in spite of the long transmission lines, Paunglaung power will substantially reduce costs when introduced into the proposed Rangoon–Pegu system (see Table XIX–15) and the Myingyan–Mandalay system (see Table XIX–21). In addition to these systems, large potential markets exist in the upper Sittang Valley and in the Irrawaddy from Pakokku to Bassein. The Paunglaung project will produce ultimately 750,000,000 kWh per year at a cost of about Ps 3·5 per kWh at the load center without benefit of secondary power sales. This can be reduced to about Ps 3·0 per kWh if secondary power is sold at P 0·8 per kWh.

b. Irrigation Benefits

The Paunglaung project has sizable irrigation benefits due to diversion of wet season flows into the proposed Yezin storage reservoir through a high level canal. For this reason the project has been included as part of the proposed Yamethin comprehensive irrigation development, which involves several new storage reservoirs, canals and pumping plants. Low cost power for pumping is an essential part of the Yamethin scheme. The minimum height of the Paunglaung dam has been determined by the level of the Yezin full reservoir. Accordingly the spillway crest will be El. 485.

c. Rainfall

For eight stations surrounding the Paunglaung watershed the annual rainfall is shown in Table XIX–29 (*see next page*) for the period of record, 1901 to 1952 inclusive, except for the years 1939 to 1946. The weighted average for the watershed varies from a maximum of 68 inches in 1927 to a minimum of 38 inches in 1920. Pyinmana appears to have the average characteristics of the watershed, and is selected as a control station for the construction of a rainfall duration curve (see Plate 26). The plate also shows the relative position of the 1952 rainfall at Pyinmana.

d. Stream Flow

Daily gauge heights April 10, 1952, to March 31, 1953, are available for the Kyidaung and Kawma Village gauges near the mouth of the Paunglaung River. The gauges were installed and stream flow measurements at Kyidaung were made by experienced personnel of the Irrigation Department regularly stationed at Pyinmana. Daily gauge readings were made by the same organization. The stage-discharge curve is given on Plate 27, and the daily discharges are given in Table XIX–30 (*see p. 633*).

e. Regulated Flow

Plate 28 contains a study of the 1952 record. The computed runoff modified by storage and evaporation would have yielded a minimum of 2,000 cusecs continuous flow which is taken as a basis for estimating firm power. For area-capacity curve, see Plate 29. From an inspection of the Pyinmana rainfall record it will be seen that eight years show 10% (or less) below the 1952 rainfall and four years show from 10 to 20% below. For the years 1919, 1920 and 1934 the rainfall is even lower and for such years resort must be had to steam or other hydroelectric sources of power. For all other dry years it is estimated that the minimum annual flow will total from 10 to 20% below 1952 and that the low flow months will yield about 25% less than 1952. It is believed that this large volume of low flow is due to beneficial effect of ground water storage. Accordingly, the minimum regulated flow is taken at 25% below the computed 1952 yield.

f. Available Power

Continuous firm power is computed as follows:

Pool El. 485, Tailwater El. 270, Gross Head 215 ft.
Average Head 215–22·5 = 192·5 ft. Net Head (95%) = 183 ft.

Continuous Power $1{,}500 \times \frac{183}{15} = 18{,}300$ kW.

Initial Output 40,000 kW @ 46% station capacity factor.
18,300 × 8760 = 160,000,000 kWh at station
0·9 × 160,000,000 = 144,000,000 kWh at Load Center.

TABLE XIX – 29
FUTURE PAUNGLAUNG HYDRO DEVELOPMENT
Annual Rainfall in Inches at Selected Stations

Year	*Yamethin*	*Tatkon*	*Pyinmana*	*Yedashe*	*Thandaung*	*Loikaw*	*Yawnghwe*	*Kalaw*	*Weighted Average**
1901	44·9	—	62·5	—	—	—	—	—	—
1902	34·9	—	45·4	—	—	—	—	—	—
1903	30·8	—	62·2	—	—	—	—	—	—
1904	34·4	—	63·7	—	—	—	—	—	—
1905	35·7	—	55·7	—	118·9	—	—	—	—
1906	27·6	—	43·9	—	217·4	—	—	—	—
1907	39·6	—	52·2	—	269·2	56·6	—	—	—
1908	37·8	—	51·3	—	237·6	53·9	—	—	—
1909	52·5	—	64·4	74·6	303·9	66·1	59·6	57·2	—
1910	44·6	—	71·8	63·3	212·9	41·2	54·8	45·8	—
1911	31·2	—	54·1	66·0	244·0	49·7	45·4	51·0	—
1912	34·3	—	53·7	69·4	219·1	46·2	42·2	50·0	—
1913	38·7	—	54·9	—	231·2	—	—	—	—
1914	34·6	—	56·3	57·0	224·1	43·9	41·2	54·8	—
1915	36·5	—	60·6	60·1	220·2	41·8	48·6	54·0	—
1916	49·9	40·1	60·1	63·3	208·7	51·4	76·2	53·3	52·9
1917	45·0	44·2	74·1	105·2	232·6	49·5	43·9	59·8	63·2
1918	35·0	26·2	55·2	66·7	260·6	49·5	48·9	51·3	47·1
1919	34·3	37·5	41·2	67·0	225·1	38·5	39·9	48·6	43·0
1920	23·7	29·5	40·5	47·2	184·2	40·3	37·0	43·0	38·1
1921	32·8	38·8	57·0	57·5	212·1	63·0	49·7	44·1	51·3
1922	39·4	40·0	54·5	61·6	223·3	40·2	49·9	54·6	48·8
1923	41·6	33·8	52·5	95·1	203·3	36·4	41·1	53·1	49·2
1924	30·7	35·9	54·7	78·0	250·0	35·1	49·2	43·9	47·2
1925	38·2	42·1	63·9	54·4	192·0	46·1	49·8	50·6	52·5
1926	46·3	58·5	68·2	65·7	210·6	38·2	47·2	55·0	58·5
1927	40·8	60·5	77·8	84·3	238·0	57·4	52·2	64·1	68·1
1928	37·7	50·3	74·9	83·5	218·9	38·5	42·9	66·9	61·7
1929	37·6	49·4	60·7	96·6	—	44·6	46·8	52·6	57·2
1930	35·9	35·7	47·5	71·7	—	45·8	56·2	46·2	46·2
1931	34·7	32·9	45·5	65·6	—	32·1	40·8	33·5	40·5
1932	35·5	29·9	55·6	53·8	—	37·1	43·8	45·3	44·2
1933	34·9	43·0	49·0	83·5	—	40·5	51·1	42·4	48·4
1934	45·5	42·1	42·8	116·4	—	43·2	37·9	45·3	50·5
1935	36·1	34·5	55·7	123·6	—	48·3	39·2	50·8	54·9
1936	28·8	28·9	51·0	71·0	—	46·2	46·0	60·2	47·0
1937	49·6	39·1	47·4	81·3	—	54·4	53·3	61·6	51·5
1938	34·6	31·6	51·4	69·6	—	47·2	43·1	53·4	47·3
1947	48·5	—	64·2	—	—	—	—	—	—
1948	34·5	—	60·1	—	—	—	—	—	—
1949	—	—	—	—	—	—	—	—	—
1950	47·7	—	—	—	—	—	—	—	—
1951	45·8	45·9	62·9	—	—	—	45·0	—	—
1952	36·5	38·8	54·4	82·8	—	39·3	—	45·0	49·1
Average	37·8	39·6	56·5	74·5	223·3	47·2	47·5	51·5	50·7

* Weighted average for Paunglaung Watershed

Ultimate Output 80,000 kW @ 34% station capacity factor.

27,500 × 8760 = 241,000,000 kWh at station
0·9 × 241,000,000 = 217,000,000 kWh at Load Center.

Secondary Power 45,000 − 18,300 = 26,700 kW.

Initial Secondary
26,700 × 5850 = 156,000,000 kWh at station.
0·9 × 156,000,000 = 140,000,000 kWh at Load Center.

Ultimate Secondary (Not Computed)

In determining ultimate output it was assumed that the continuous firm power could be increased 50% by the addition of upstream storage reservoirs. A fifth unit of 20,000 kW would be added at some future date if justified by the water supply or capacity factor.

g. Penstocks

The normal maximum demand from each unit will be 1,640 cusecs based on 20,000 kW per unit at a 183-ft. average net head. For a 12-ft. diameter penstock, the maximum velocity would be 14.5 ft. per sec. at average head, or 16·5 ft. per sec. at extreme low water for the 161-ft. minimum net head and 1,860 cusecs maximum demand. Accordingly five 12-ft. penstocks would be installed in the concrete dam, and would be located to supply the powerhouse at the downstream toe of the dam. In view of the narrow canyon site (see general layout Plate 30), the powerhouse would occupy the entire width of the river, and the spillway would be located in a natural saddle in the left abutment.

h. Diversion

The year 1952 produced a flood of 26,400 cusecs during the wet season. This is considered a normal year. The four year frequency flood would be 30,800 cusecs based on proportionate annual rainfalls at Pyinmana (see Plate 26) and would be 41,700 cusecs based on Meyers rating, 10% of maximum*. It is concluded that a construction flood of about 41,700 should be anticipated during the wet season and about 5,000 during the dry season from December to June inclusive.

* Meyers maximum equals 10,000 times the square root of the drainage area (1,741 square miles), or 417,000 cusecs.

i. Estimated Cost

Quantities and costs are based on incomplete data including a topographic survey of the dam site, reconnaissance survey by the Burma Geological Department, and stream flow measurements from April 10 to date at Kyidaung village near the dam site. Rainfall records are available for about 50 years at eight communities surrounding the watershed. The reservoir capacity and the transmission line location have been determined from the Burma Survey maps, one inch to one mile, with 50-ft. contour interval. The cost estimate is given in Table XIX-31, "Estimated Cost—Initial Installation" (*see p. 636*). Excavation, concrete, and steel prices are based on cost of similar work recently completed in Burma. Hydraulic and electrical machinery are estimated from preliminary quotations by American manufacturers. A contingency and engineering factor of 20% has been allowed, in addition to a fee for detailed exploration and design of approximately 4·0% of the total.

j. Production Costs

The estimated annual cost of power at the load center is computed as follows:

Capital recovery with interest at 4·25%

Description	*Life in Years*	*Factor*	*Investment*	*Annual Cost*
			$	$
Electrical Controls	20	·0752	150,000	11,300
Generators and Portion of Substation	25	·0655	1,800,000	118,000
Turbines, Racks, etc.	35	·0555	1,500,000	83,300
Transmission Line	35	·0555	5,510,000	306,000
Civil Eng. Works Buildings	50	·0491	11,840,000	582,000
Operation and Maintenance		·0119	20,800,000	247,500
Annual Cost (6·5%)				$1,348,000

Note: Interest has been assumed at 4% for 75% of the total investment and 5% for the remainder.

*Initial Development ·065 × 18,800,000 = $1,223,000

Cost per kWh at Load Center:

	kWh	*Mills*	*Pyas*
Firm Power (par. f.)	144,000,000	8·50	4·05
75% Sales	108,000,000	11·32	5·39

If secondary can be sold at 0·8 pyas per kWh (1·68 mills)

Selling 100% of secondary power, 140,000,000 @ 1·68
$235,000

Cost of firm power

$$\frac{1{,}223{,}000 - 235{,}000}{144{,}000{,}000} = 6{\cdot}85 \text{ mills } 3{\cdot}26 \text{ pyas}\dagger$$

Selling 50% of secondary power 70,000,000 @ 1·68
$117,500

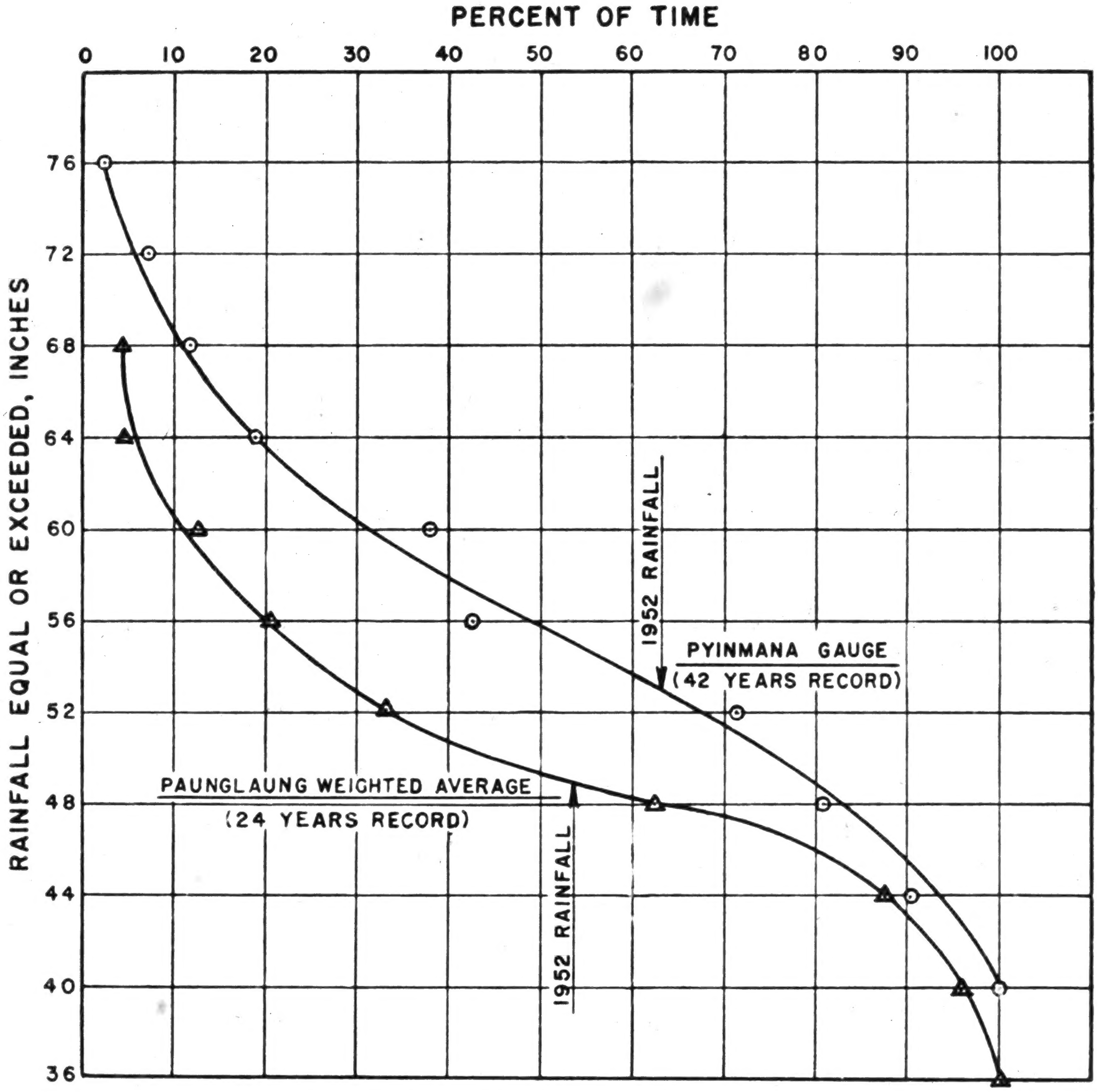
Cost of firm power

$$\frac{1{,}223{,}000 - 117{,}500}{144{,}000{,}000} = 7{\cdot}7 \text{ mills } 3{\cdot}66 \text{ pyas}$$

---

* The total cost of the initial development is reduced by $2,000,000 credit due to irrigation benefits from diversion of flood waters into the proposed Yezin reservoir.

† Delivered at Pyinmana the cost would be Pyas 3·02 per kWh without benefit of secondary power sales or Pyas 2·25 if all the secondary is sold at Pyas 0·8 per kWh.



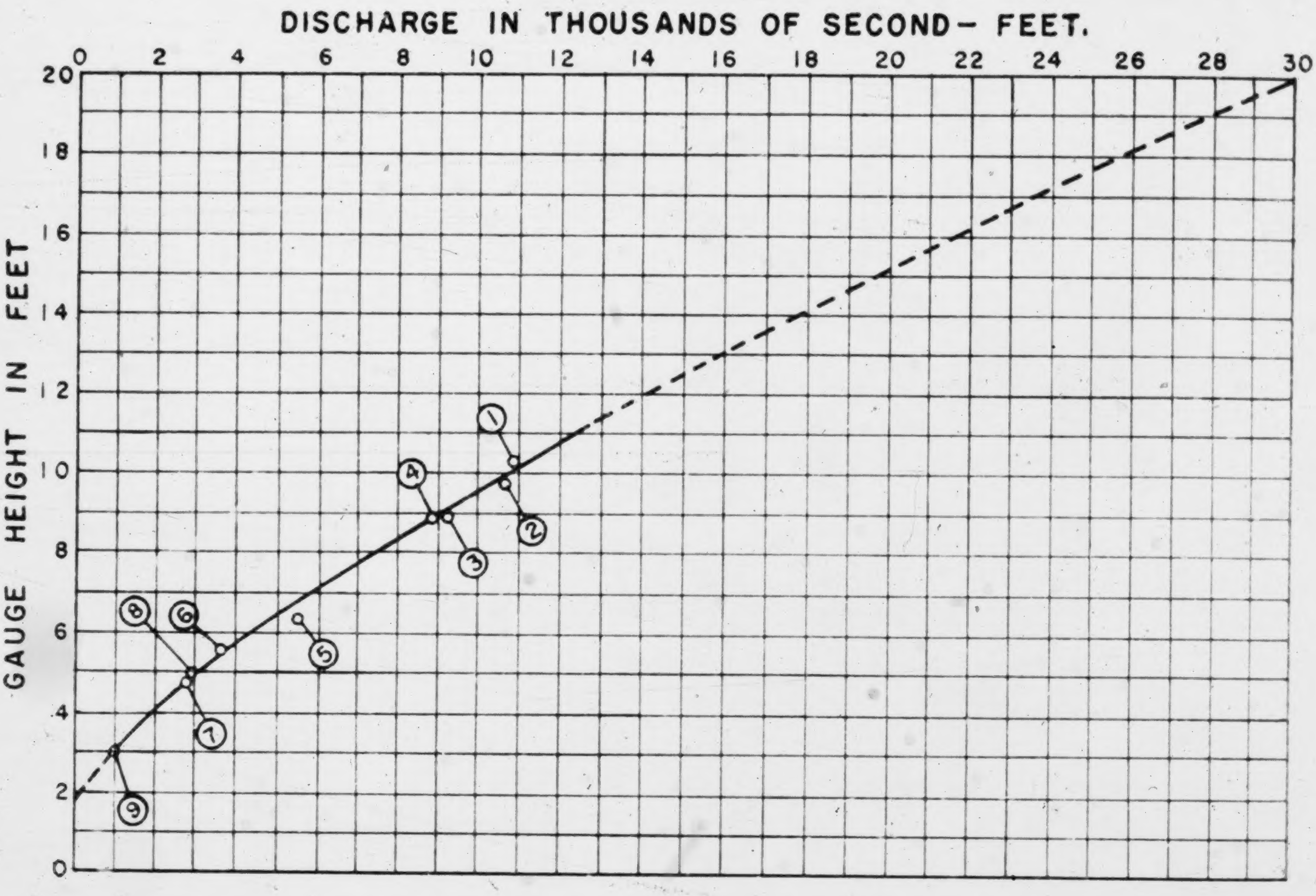
MINISTRY OF NATIONAL PLANNING

PYINMANA GAUGE AND
PAUNGLAUNG WATERSHED

RAINFALL DURATION CURVE

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. DATE PLATE
CK. BY. GMT MAY, 53. NO. **26**



NO	DATE	GAUGE READING	DIS- CHARGE	RIVER STAGE
1	5-10-52	10·3	10,978	
2	16-10-52	9·8	10,652	
3	19-10-52	9·0	9,199	
4	28-10-52	8·9	8,857	
5	28-11-52	6·4	5,544	
6	19-12-52	5·5	3,722	
7	15-1-53	4·8	2,812	
8	31-1-53	5·0	2,903	
9	10-4-52	3·0	991	

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PAUNGLAUNG RIVER HYDRO PROJECT

STAGE-DISCHARGE CURVE

PAUNGLAUNG AT KYIDAUNG VILLAGE

KNAPPEN TIPPETTS ABBETT, ENGINEERING CO.
NEW YORK RANGOON

DR. BY
CK. BY G.M.T.
DATE MAY, 53.
PLATE NO. 27

TABLE XIX - 30

FUTURE PAUNGLAUNG HYDROELECTRIC DEVELOPMENT

1952-1953, Rainfall and Runoff at Dam Site

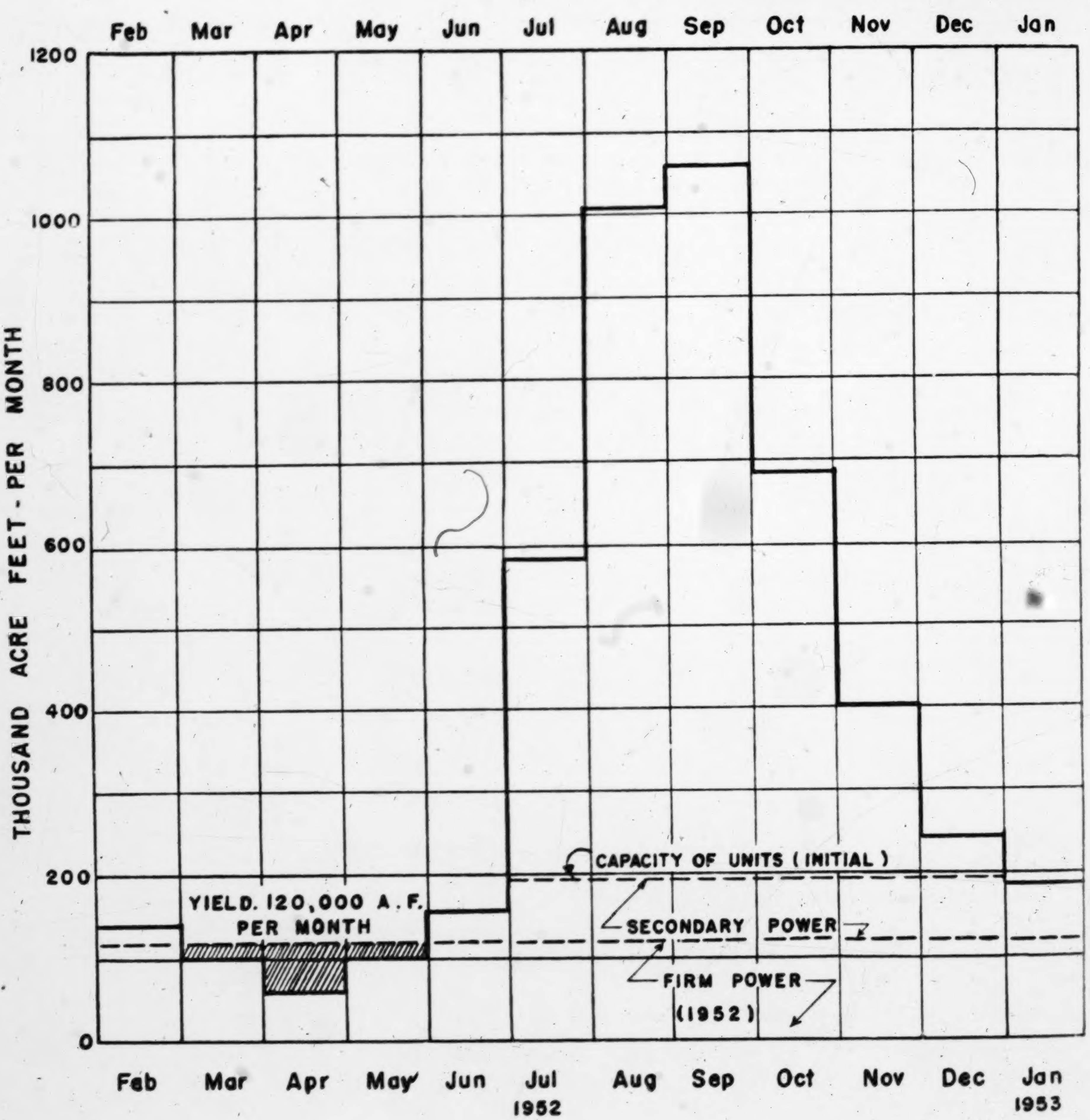
	Feb.-Mar.	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Jan.*
Rainfall*	2·24	0	1·74	6·41	12·40	11·48	10·83	8·51	0·74	0	0·34
1	Estimated discharge 60 days @ 2,000=120,000 d.s.f.	9,000 d.s.f.	1,000	3,360	6,330	18,190	20,090	14,025	10,540	4,690	Say 31 days @ 3,000=93,000 d.s.f.
2			1,000	3,360	6,170	17,000	18,000	12,975	9,580	4,690	
3			1,000	3,750	6,970	16,400	16,400	13,150	8,935	4,545	
4			1,000	3,750	5,705	18,380	14,920	11,575	8,440	4,545	
5			730	4,400	5,835	19,140	14,025	10,540	7,945	4,545	
6			1,500	4,140	4,270	17,000	13,675	10,540	7,780	4,545	
7			2,000	2,880	4,835	14,560	12,800	10,540	7,615	4,400	
8			1,500	2,000	4,400	14,380	12,275	10,700	7,450	4,400	
9			1,000	2,000	4,270	13,850	19,140	13,150	7,615	4,270	
10		1,000	1,000	1,500	4,270	14,025	23,900	14,920	7,615	4,270	
11		1,000	730	1,500	5,270	14,560	21,040	13,675	7,450	4,140	
12		1,000	730	1,000	6,970	15,640	18,570	12,975	7,130	4,010	
13		1,000	1,000	1,000	6,810	14,380	17,200	13,325	6,970	4,010	
14		1,000	1,000	1,300	5,705	17,200	17,800	11,925	6,650	3,880	
15		1,000	730	2,000	5,850	19,140	16,600	10,380	6,490	3,880	2,810
16		1,000	730	2,000	6,490	17,400	15,100	11,925	6,490	3,880	
17		1,000	370	2,330	7,138	16,200	14,025	10,380	6,330	3,750	
18		1,000	370	1,500	7,615	15,100	12,800	10,060	6,170	3,750	
19		1,000	730	2,000	10,060	15,820	13,500	9,260	6,010	3,750	
20		1,000	1,500	1,800	12,975	15,280	18,950	9,260	5,850	3,620	
21		1,300	2,000	1,800	10,380	14,740	26,400	11,750	5,850	3,620	
22		1,300	4,835	1,500	10,060	14,025	25,000	11,225	5,705	3,620	
23		1,000	2,330	1,800	10,220	13,500	22,220	10,060	5,560	3,620	
24		1,000	1,500	2,000	11,400	13,675	19,710	9,420	5,415	3,620	
25		1,000	1,500	3,100	11,400	15,460	17,400	9,420	5,270	3,620	
26		1,000	1,800	4,270	11,400	17,200	22,430	9,100	5,125	3,620	
27		1,000	2,330	3,880	11,925	18,000	19,330	9,420	5,125	3,490	
28		730	2,550	4,835	17,600	17,200	18,000	8,935	4,980	3,490	
29		730	2,550	5,705	22,640	15,460	14,920	9,260	4,835	3,490	
30		730	2,770	6,490	22,220	21,420	13,850	10,700	4,835	3,490	
31		1,000	3,360		20,850	20,800		11,750		3,360	2,900
Total†	120,000	30,790	47,145	82,950	287,033	505,125	530,070	346,320	201,755	122,610	93,000

* Annual Rainfall, Pyinmana 54·7 inches or 4·56 feet.

† Annual Runoff, Paunglaung River at Dam Site 2,366,798 d.s.f.

Runoff Factor $\frac{2,366,798 \times 2}{4\cdot56 \times 640 \times 1741} = 93\cdot2\%$

(Based on Pyinmana rainfall over the entire watershed).



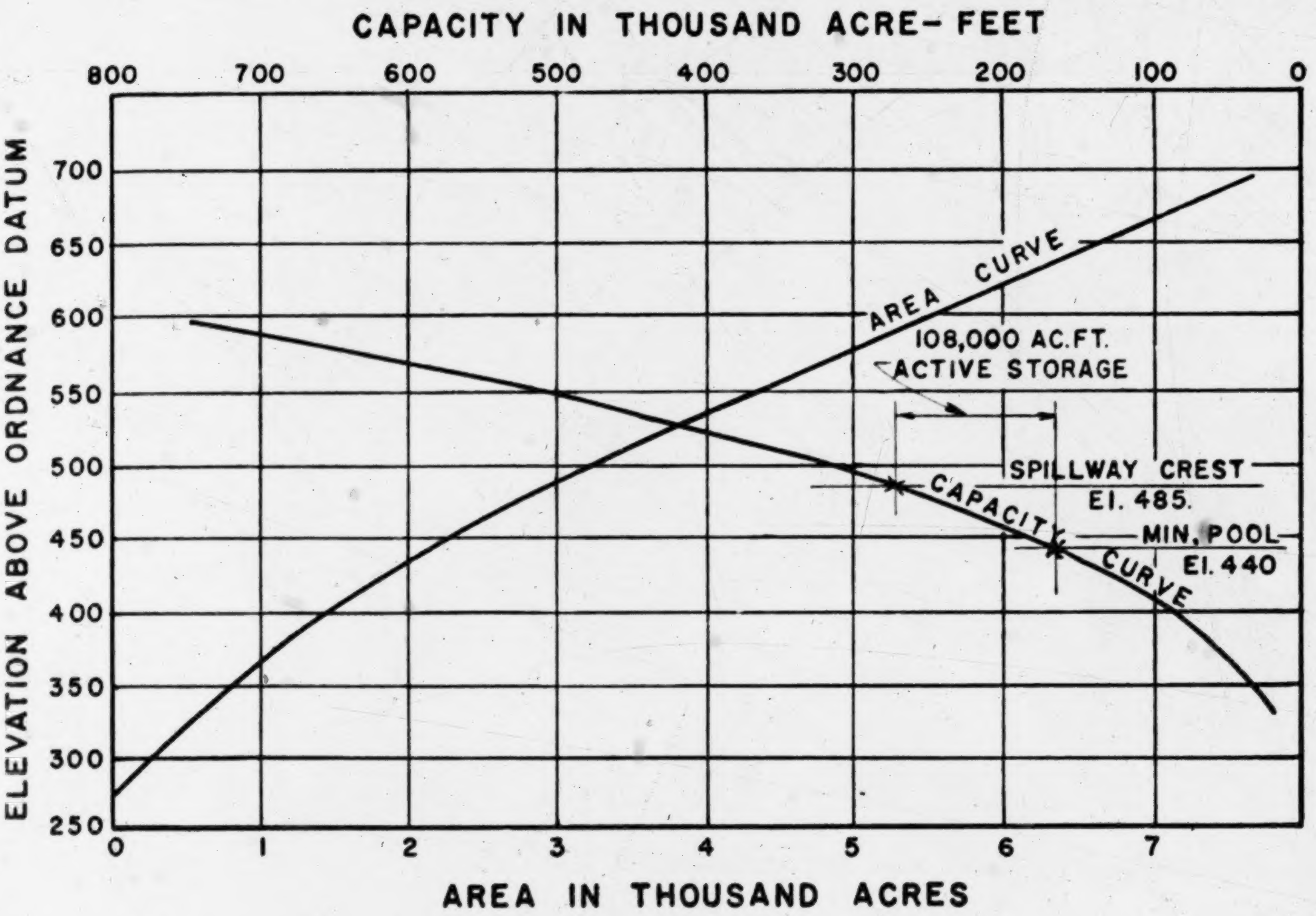
MINISTRY OF NATIONAL PLANNING

PAUNGLAUNG HYDRO PROJECT

MONTHLY RUNOFF
AT DAM SITE.

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON

DR. BY.	DATE	PLATE
CK. BY. GMT	MAY, 53.	NO. 28



WATER SHED AREA = 1741·5 SQ. MILES

ASSUMED BED LEVEL AT DAMSITE = 270 O.D.

MINISTRY OF NATIONAL PLANNING

PAUNGLAUNG RIVER HYDRO PROJECT
AREA–CAPACITY CURVE
PAUNGLAUNG RESERVOIR.

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON

DR. BY. L.P. DATE PLATE
CK. BY. GMT MAY, 53. NO. **29**

TABLE XIX – 31

PAUNGLAUNG HYDROELECTRIC PROJECT

Estimated Cost—Initial Installation (US Dollars)

No.	Description	Quantity	Unit	Unit Cost	Cost
				$	$
1	Exploration and Design	l.s.	—	—	800,000
2	Clearing Reservoir	2,000	acre	50·00	100,000
3	Access Roads	3	mi.	10,000·00	30,000
4	Cofferdam	1,000	l.f.	150·00	150,000
5	Excavation, Dam Foundation	50,000	c.y.	3·00	150,000
6	Foundation Preparation, Dam	15,000	s.y.	2·00	30,000
7	Drilling Holes for Grout	24,000	l.f.	1·00	24,000
8	Grouting Cutoff	36,000	c.f.	2·00	72,000
9	Mass Concrete	420,000	c.y.	15·00	6,300,000
10	Penstocks, 5 @ 150×500	375,000	lbs.	0·40	150,000
11	Excavation, Spillway	240,000	c.y.	1·00	240,000
12	Excavation, Powerhouse	40,000	c.y.	5·00	200,000
13	Concrete, Powerhouse	7,500	c.y.	40·00	300,000
14	„ Channel Lining	2,000	c.y.	32·00	64,000
15	„ Spillway Lining	5,000	c.y.	32·00	160,000
16	Reinforcing Steel	800,000	lbs.	0·10	80,000
17	Trash Racks and Frames	480,000	lbs.	0·25	120,000
18	Headgates, Frames, Hoists	360,000	lbs.	0·50	180,000
19	Headworks Crane	l.s.	—	—	20,000
20	Hydraulic Machinery	56,000	h.p.	20·00	1,120,000
21	Electrical Machinery	40,000	kW	35·00	1,400,000
22	Electrical Controls	l.s.	—	—	120,000
23	Substation Complete	l.s.	—	—	300,000
24	Powerhouse Superstructure	250,000	c.f.	1·00	250,000
25	Crane Complete	l.s.	—	—	90,000
26	Living Quarters	l.s.	—	—	300,000
	Subtotal				12,750,000
27	Transmission Line	230	mi.	20,000·00	4,600,000
	Subtotal				17,350,000
28	Engineering and Contingencies	20%			3,450,000
	Grand Total				$20,800,000

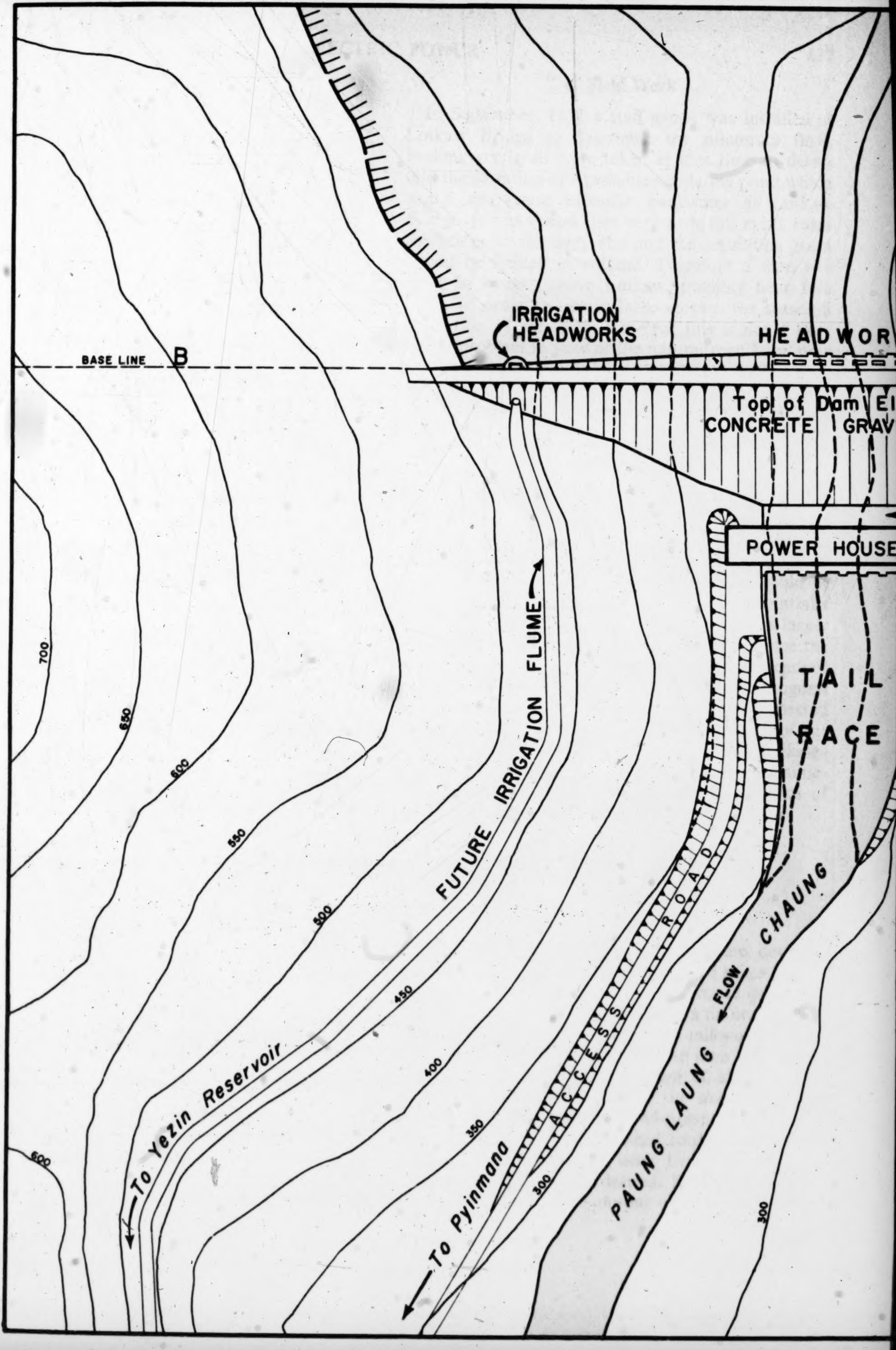
2. BAWGATA PROJECT

a. Description

The Bawgata hydroelectric project is located near Kyaukyi, lower Sittang watershed (see Plate 1). Surveys were commenced by the Hydroelectric Survey Board during the 1948–49 dry season and were violently interrupted by the Karen insurrection. The initial and ultimate costs for the project are about equal to the Paunglaung project based on preliminary estimates. The latter has irrigation and flood control benefits in addition to power, whereas the former provides power only. The Paunglaung project does not involve flooding villages and farm lands whereas Bawgata is objectionable because of such damages. Accordingly the Bawgata field investigations and construction should be deferred until Paunglaung project is well advanced.

b. Estimated Costs

The initial installation at the upper site would consist of 40,000 kW under 950 ft. average net head requiring three miles of pipe line and a concrete gravity dam 100 ft. high. The cost would be about $17,500,000 including transmission line. The ultimate installation at the upper site would be 90,000 kW at a cost of approximately $29,300,000. At the lower site the final installation would consist of 60,000 kW under 650 ft. average net head requiring five miles of pipe line and costing about $21,200,000 including


IRRIGATION HEADWORKS
HEADWOR
BASE LINE
B
Top of Dam El
CONCRETE GRAV
POWER HOUSE
TAIL RACE
FUTURE IRRIGATION FLUME
ACCESS ROAD
PAUNG LAUNG CHAUNG
FLOW
To Yezin Reservoir
To Pyinmana
700
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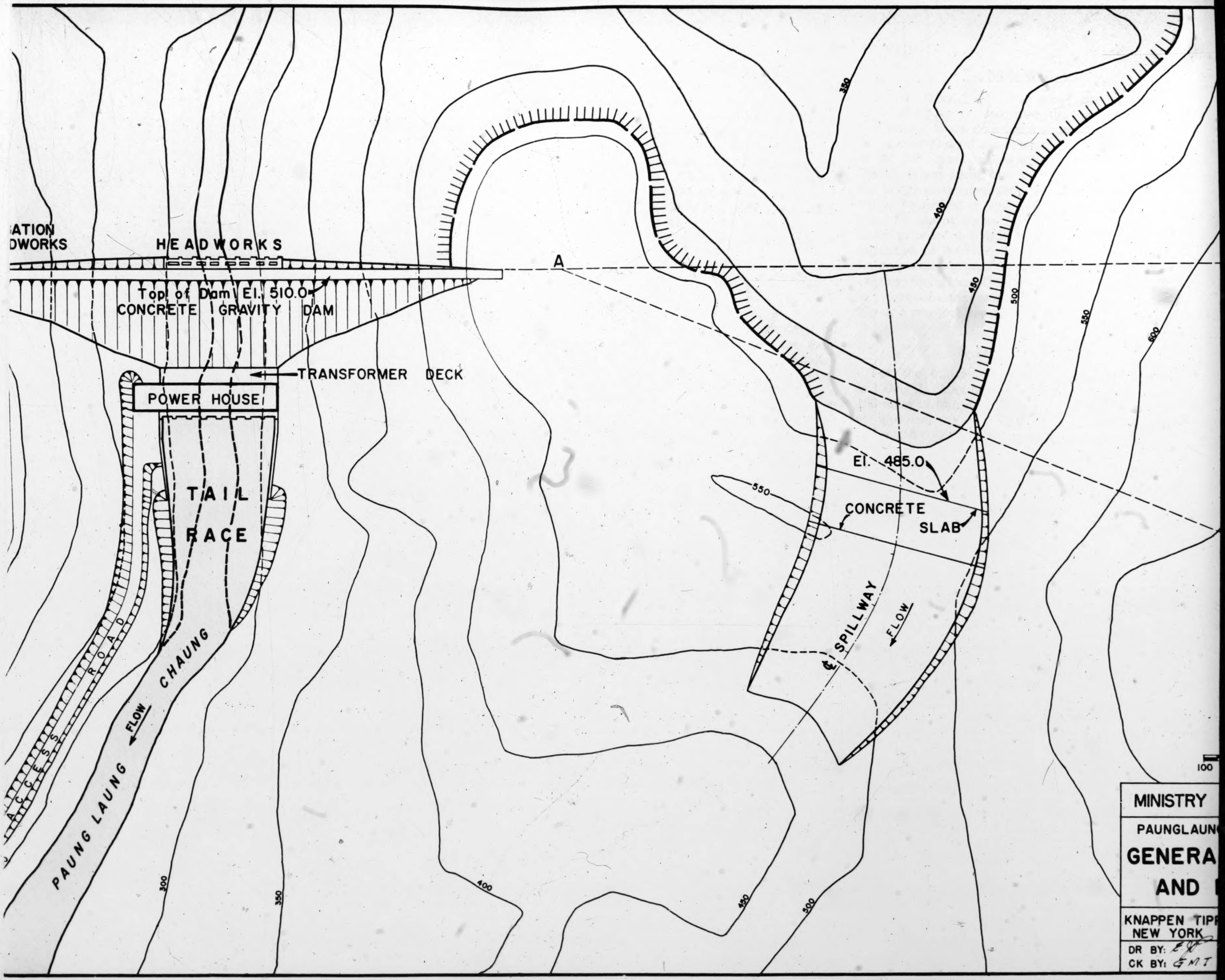
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A
Top of Dam El. 510.0
CONCRETE GRAVITY DAM
TRANSFORMER DECK
POWER HOUSE
TAIL RACE
ACCESS ROAD
PAUNG LAUNG CHAUNG
FLOW
El. 485.0
CONCRETE SLAB
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℄ SPILLWAY
FLOW
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350
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500
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MINISTRY

PAUNGLAUNG

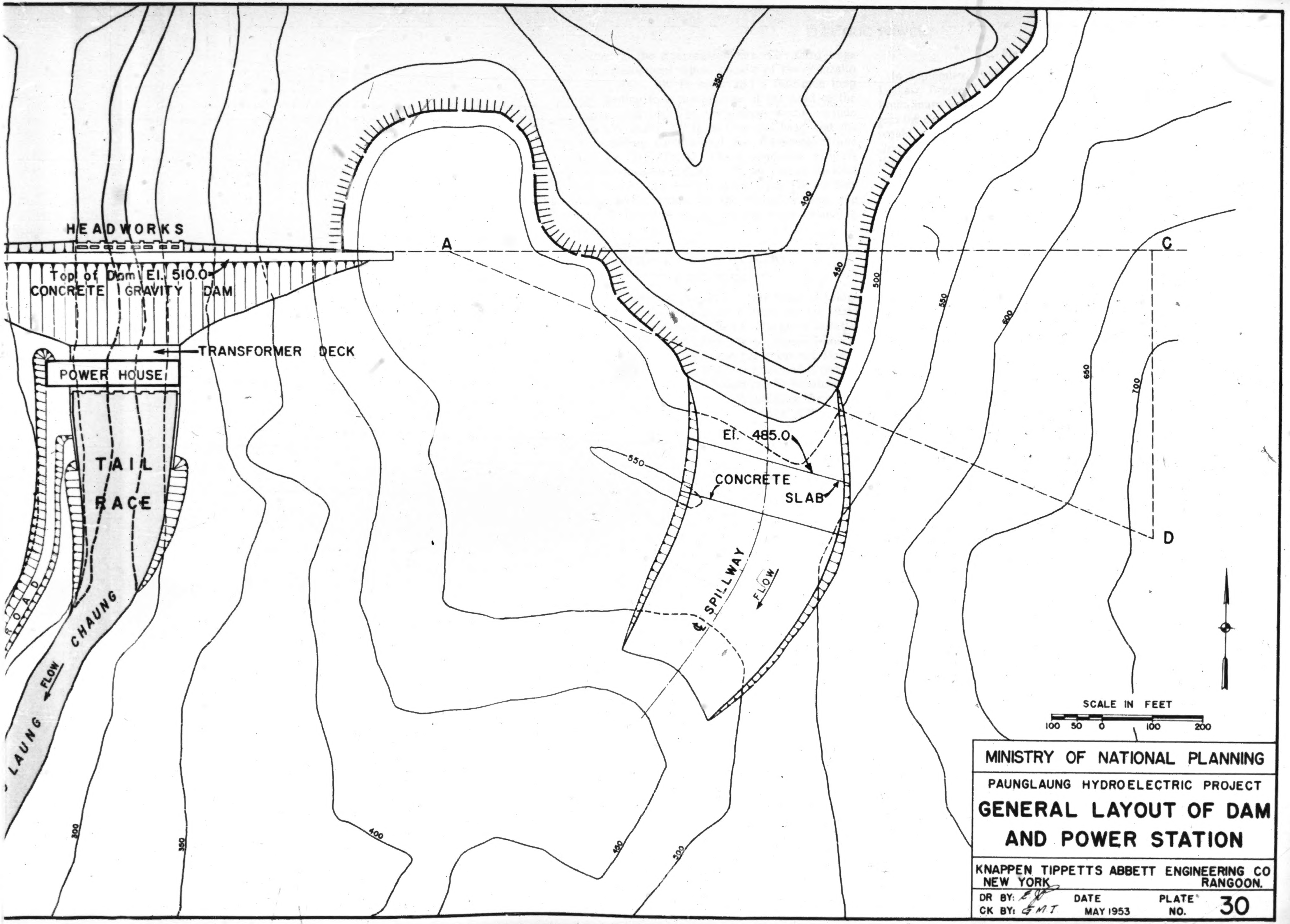
GENERA

AND

KNAPPEN TIPP
NEW YORK

DR BY: E.J.
CK BY: G.M.T

APPE


HEADWORKS
Top of Dam El. 510.0
CONCRETE GRAVITY DAM
TRANSFORMER DECK
POWER HOUSE
TAIL RACE
ROAD
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CONCRETE
SLAB
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MINISTRY OF NATIONAL PLANNING

PAUNGLAUNG HYDROELECTRIC PROJECT

GENERAL LAYOUT OF DAM AND POWER STATION

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON.

DR BY: E.J. DATE PLATE NO. 30
CK BY: G.M.T. MAY 1953

APPENDIX NO. 2

additions to the transmission line. The third stage of the development would consist of the Yunzalin diversion dam, 140 ft. high, and a four-mile long tunnel feeding to a powerhouse at the head of the Bawgata reservoir. The installation would include 40,000 kW under 700 ft. average net head and the total including dam, tunnel and transmission line would be $15,500,000. Three combined projects would produce 630,000,000 kWh per year at the load center at a cost of 8·34 mills or 3·97 pyas. The markets for this power would be the Rangoon area, the Sittang Valley and the Irrawaddy from Prome to Bassein.

3. BALU CHAUNG PROJECT (LOIKAW)

a. Description

A small, low-cost project for near future development can be undertaken at Loikaw on the Balu Chaung. For location see Plate 1. The initial installation should be about 3,000 kW to supply Mawchi Mine, Loikaw, Taunggyi and the proposed Lough Keng zinc development. If a heavy demand is created at the zinc mine the initial plant can be expanded in easy stages to about 25,000 kW utilizing the upper site, five miles from Loikaw. Utilization of the upper site involves a canal 2½ miles in length with initial capacity of 500 cusecs (ultimate 2,500 cusecs) in order to develop 200 ft. of head. Short penstocks approximately 800 ft. in length would connect the canal forebay to the powerhouse. No dam is required in the initial development, but one may be constructed in the future to supply pondage for daily fluctuation in water demand. The dam would be about 20 ft. high in the deepest part of the river.

b. Middle and Lower Falls

A reconnaissance was made in January, 1952 of the middle falls, indicated on the Burma Survey topographic maps to be 600 ft. in height. The falls are 15 miles from Loikaw and difficult of access. Only a distant view could be had in the time allotted for the reconnaissance. A third fall 600 ft. or more in height exists downstream from the middle falls, but could not be approached due to rugged canyon walls and lack of jeep trails. The middle and lower falls are too inaccessible for consideration in the near future. There is a total fall of 2,200 ft. from the head of the upper falls to the foot of the lower falls in a distance of ten miles. This would provide 130,000 kW continuous power without river regulation other than that now supplied by Inle Lake. This would be exceptionally low cost power, but large markets and large power installation are needed to justify the expense of exploration, access road and transmission line.

c. Field Work

In September, 1952 a staff gauge was installed at Loikaw Bridge to determine the minimum flow. Preliminary levels were taken at that time to determin the elevation of a possible regulating pond which would not cause excessive backwater at Loikaw Bridge. It was found that very little fall exists from the bridge to the dam site, and the regulating pond would be limited in volume. Therefore a dam site must be sought above Loikaw, possibly near Inle Lake, in order to obtain large storage for seasonal regulation of the river. However this is not a near future problem in view of the natural regulation now existing. Since June, 1953, a location survey has been in progress for the canal intake and alignment, forebay and penstock layout, and powerhouse location.

d. Estimated Costs

For the initial installation at the upper site, including 2½ miles of canal, 3,000 kW capacity, and 150 miles of transmission line, the cost is estimated at approximately $1,800,000. Assuming 50% load factor, the cost per kWh at the load center would be 9·92 mills or 4·73 pyas. The cost can be substantially reduced if the load factor is improved or if a larger market and installation can be developed. Since the power site is over 300 miles from Rangoon it cannot be considered as an economic source for the Rangoon area. At some future date it may be interconnected with the central transmission system by way of the Mawchi–Toungoo Road or the proposed Loikaw–Pyinmana Road in order to supplement the Paunglaung and Bawgata hydroelectric plants at times of drought or excessive market growth.

4. LAMPHA CHAUNG (MOULMEIN SUPPLY)

a. Description

A possible highhead project for future development exists on the Lampha Chaung 55 miles east of Moulmein. Aerial photos have been made indicating a rocklined gorge downstream from a natural storage basin at El. 3,000 controlling 11 sq. miles of drainage area. Apparently a 200-ft. concrete arch dam could be constructed with gross storage of about 32,000 acre feet. This would control the average annual output, and would yield about 86 cusecs of continuous flow. Some 2,500 ft. of net head could be developed with a four-mile pipe line, using two powerhouses if stage development were desired. Based on the total net head a continuous output of 19,500 kW could be obtained.

b. Estimated Costs

For the initial installation including concrete arch dam, two miles of pipe line, 1,340 ft. net head, 16,000 kW capacity, and 55-mile transmission line, a preliminary cost estimate is $6,200,000. Assuming 50% load factor and the entire output salable, the cost at load center would be Ps 2·96 per kWh. The output is computed to be 64,500,000 kWh delivered at Moulmein, Bilugyun, and possibly Thaton. The above analysis indicates a highly favorable power site and it is recommended that field investigations be commenced when security conditions permit.

5. NAMTU RIVER PROJECT, MAYMYO

a. Description

At the Pyaungsho Rapids, Namtu River, about 20 miles east of Maymyo, there is a large potential source of power. In an eight-mile length the river drops nearly 300 ft., affording some 75,000 kW of continuous power without construction of a storage dam. The low flow is reported to be 3,000 cusecs, an estimate consistent with the very large drainage area. A major hairpin bend in the river alignment permits the eight-mile reach to be developed by a canal about five miles in length. A moderate installation of 25,000 kW could be economically justified for the initial development. This could be expanded by regular stages as more power is needed. The project would adequately serve the northern Shan States and the Mandalay Division for many years. In view of its inaccessibility, it has been given priority later than the Paunglaung and Loikaw developments.

b. Estimated Costs

The initial installation, including five miles of canal, 25,000 kW capacity under 275 ft. net head, and 120-mile transmission line, would cost $9,900,000 based on preliminary studies, aerial photos and topography from Burma Survey maps. Assuming 50% load factor the cost per kWh at the load center would be 5·88 mills or 2·80 pyas. This site could be developed at low cost without a storage dam up to 75,000 kW and with a low diversion dam for daily regulation could serve up to 150,000 kW based on 50% load factor.

6. MU RIVER HYDROELECTRIC PROJECTS

A possible source of intermittent "secondary" power will exist at proposed irrigation projects in the Mu River region. Map study and information available on irrigation plans indicate the following characteristics:

Relative Priority	*I*	*II*	*III*
Power house location	West Side Canal	Wetto Dam	Storage Dam
Approximate continuous flow, c.f.s.	1,200	4,000	5,000
Average net head, feet	70	48	38
Approximate continuous power, kW	5,600	12,800	12,660
Initial installation, kW	10,000	20,000	20,000
Cost including trans. line to Monywa	$2,400,000	$5,600,000	$6,100,000
Output at load center, kWh	46,500,000	106,500,000	105,000,000
Cost at load center, mills/kWh	3·36	3·42	3·77
Cost at load center, pyas/kWh	1·60	1·63	1·80

The output would be useful when a large power system, which can accept energy whenever the irrigation system can release water, has been developed. Accordingly the installations should be given a priority later than the Myingyan steam plant and Paunglaung hydroelectric plant. The construction of the Mu River plants would also be dependent on completion of the Mu River irrigation dams which are recommended in the irrigation chapter of this Report.

7. EXPANSION OF EXISTING HYDROELECTRIC PLANTS

In Table XIX–4 "Initial Diesel and Hydro Plants at 36 towns," the following hydroelectric planning by the Electricity Supply Board is noted: Item 23, Mogok, existing hydroelectric plant to be surveyed for expansion. Item 25, Panghai E'Hang, purchase from Burma Corporation, Namtu. Item 33, Tavoy, From Anglo-Burma Tin, Hpaungdaw plant, increase height of dam.

When security conditions permit, these existing plants should be examined for enlargement and the addition of storage reservoirs so that firm power may be obtained. Two of the plants, Namtu and Hpaungdaw are well located for interconnecting with the proposed network and will serve an extended area. This would appear to justify considerable expansion of the Namtu plant to serve Mandalay and the Hpaungdaw plant for Moulmein at times of shortage at other plants or to accommodate excessive growth not now foreseen. It is probable that the small (420 kW present capacity) Mogok plant will remain isolated, as interconnection would be costly.

Some discussion has been had in regard to enlargement of the Maymyo hydroelectric plant from 448 kW to about 650 kW. If found economical, this should be done, and interconnection should be made to the Lashio–Mandalay proposed transmission line.

However, this small increment cannot be considered as an early temporary solution of the Mandalay shortage, where the near future demand has been estimated to be as high as 12,800 kW (see Table XIX-3).

H. PROPOSED EXPANSION OF BASIC TRANSMISSION SYSTEM

1. MYINGYAN, CHAUK, MAGWE, PYINMANA

The Rangoon and Mandalay loop transmission lines should be completed under the Pegu hydroelectric project and the Myingyan steam plant project, respectively, by the end of 1957. The Sittang Valley transmission line should be completed under the Paunglaung project by 1960. Coincident therewith, or immediately following the Paunglaung project, there should be completed a 132-kV line from Myingyan to Chauk, Magwe, and Pyinmana in order to bring Myingyan power southward to the oil fields and the populous Magwe district. Conversely, Paunglaung power would move to that area over a short efficient connection giving dependable service from two sources to Magwe District (see Plate 1 for location and Table XIX-32 (*see p. 641*) for estimated 1961 demand). The existing steam plant at Chauk, 11,300 kW capacity, should be interconnected to supply additional power from Magwe to Mandalay. If the completion of the Paunglaung project is delayed beyond 1960, the date proposed in this Report, then power from Chauk will in all probability become a necessity for the Mandalay division.

2. THE SATTHWA, PROME, LETPADAN LINE

This should be constructed as soon as possible after the Myingyan, Magwe, Pyinmana line in order to bring Paunglaung power to towns on the middle Irrawaddy and the Prome railroad. Also this line is required preparatory to extending service into the delta, and probably should be designed for 275 kV in view of the long transmission distance involved. A tie should be made to the 1,600-kW steam plant at Thayetmyo for interchange of power, conserving fuel when excess hydroelectric power is available.

3. HENZADA, BASSEIN, MAUBIN, RANGOON

In order to bring low cost hydroelectric power to large potential markets in the delta, a 275 kV loop should be constructed from Henzada through Bassein and Maubin to Rangoon. Large diesel plants which are to be installed under the initial program will be placed in reserve after about ten years of active use. Such plants will serve as standby for protection against transmission line outages or delays in completing extensions to growing new load centers.

4. PAYAGYI, THATON, MOULMEIN, TAVOY

These towns should be connected to the basic network in order to interchange power from the proposed Rangoon loop and the proposed Lampha and enlarged Hpaungdaw hydroelectric stations. The lighter loads make it possible to utilize 132 kV even though the transmission distance is long. Also power sources and markets are distributed along the proposed line, a condition that results in smaller losses and lower design voltage than for a long line with power plant at one end and market at the other.

5. THE MYINGYAN, YE-U, SHWEBO, SAGAING LINE

This line should be constructed when the Mu River irrigation project is undertaken in order to supply power for pumping as well as for domestic loads. Ultimately the small hydroelectric plants described in par. G.6 of this chapter would be connected to this loop. In view of relatively small loads and markets interspaced with power sources the 132 kV design is believed suitable.

6. YE-U, WETTO, KATHA

When the Mu River power plants are completed, it will be necessary to construct a line from the loop described in the preceding paragraph to the power plants near Wetto. Possibly an extension to Katha can be justified to serve that town and other communities along the railroad.

7. MANDALAY, MAYMYO, LASHIO

When a dependable source of power has been developed at Pyaungsho Rapids on the Namtu River, or storage has been provided at the existing Namsan Falls plant, a connecting line should be provided from Mandalay to Lashio. A tie should be made to Maymyo hydroelectric plant for interchange of power.

8. THE MAWCHI, LOIKAW, TAUNGGYI, LOUGH KENG LINE

This is included in the Balu Chaung hydroelectric project in order to reach all possible markets with low cost hydropower. At a future date the extension from Taunggyi to Maymyo should be constructed. This will assist the Mandalay–Lashio system if shortages occur and will provide power during initiation or enlargement of the Pyaungsho Rapids project.

9. LOILEM TO NAM PANG HYDROELECTRIC STATION

If the low cost hydroelectric power on the Nam Pang is developed to serve the eastern Shan States, a transmission line should be constructed along the Keng Tung road to tie in with the basic network at Loilem.

I. DIESEL PLANTS FOR OUTLYING TOWNS

Certain remote towns should be supplied by diesel plants for many years to come. Ultimately, these towns would be the recipients of power units no longer needed in the central Burma system. Proposed installations and estimated peak demands are summarized from Table XIX–32 (*see next page*):

Town	*Estimated 1961 Peak Demand in kW*	*Proposed Installation, kW*
Victoria Point	500	800
Mergui	1,700	2,000
Sandoway	500	800
Kyaukpyu	1,300	2,000
Ramree	300	500
Cheduba	300	500
Homalin	300	500
Singkaling Hkamti	200	300
Myitkyina	1,900	2,500
Bhamo	1,100	1,500
Keng Tung	200	300

The estimated demand is based on increases in population and standards of living resulting from the current industrial program. Smaller installations listed in Table XIX–4 should be regarded as "stop gap" provisions to be completed in the next few years.

J. LARGE HYDROELECTRIC SITES FOR FUTURE STUDY

On the Nam Teng River, 50 miles southeast of Loilem, there is a large power source. The river has a minimum flow of 1,000 cusecs and falls 800 ft. in 15 miles. Apparently this is less favorable for low cost power than the Balu Chaung at Loikaw, where the fall is more concentrated (2,200 ft. in ten miles), the access is not so difficult, and transmission distance is less. A concentrated fall of 396 ft. is reported for the Nam Teng which should be compared with a 600 ft. concentrated fall on the Balu Chaung.

On the Nam Pang River, just downstream from the Keng Tung road, there is a major power source. The low flow is 2,000 cusecs and the fall is 800 ft. in 15 miles. For reasons given above this is less favorable than the Balu Chaung power site, but appears equal to the Nam Teng. Field investigations and stream flow measurements will be required to make a choice between these two power sites.

On the Mon River above the Mezali irrigation structure there is an excellent source of power, well located to serve central Irrawaddy markets supplementing the Paunglaung and Bawgata developments. At present this is not favored due to insurgent activity and probable flooding of rice lands. Field investigation should be undertaken when the need for additional power in that area develops.

K. STREAM FLOW MEASUREMENT

A hydrologic division should be created within the Government organization to collect, publish, and distribute river discharge measurements and other hydrologic data. This division should install staff or recording river gauges, and make sufficient stream flow measurements to calibrate each gauge. Rating curves and tables should be published periodically along with daily gauge heights. The division should install rain gauges in critical drainage basins and near prospective power sites to supplement the scattered gauges already in operation at the principal towns and villages. The division should be attached either to the Electricity Supply Board or Irrigation Department. A list of suggested gauging stations for power use follows:

River	*Location*	*River Gauge*	*Rain Gauge*
Pegu	Zaungtu	Existing	Existing
Pegu	Taikkyi	"	"
Saingdin	Saingdin Falls	"	"
Paunglaung	Near mouth	"	Not required
Balu Chaung	Loikaw	"	Existing
Bawgata Chaung	Kyaukkyi	Re-establish	Re-establish
Lampha Chaung	Near mouth	Establish	Establish
Hpaungdaw Chaung	Near powerhouse	"	"
Namtu	Near mouth	"	Not required
Nam Yao	Namsan Falls	"	Establish
Mu	Wetto	"	"
Nam Pang	Keng Tung Road	"	"

L. SUMMARY AND RECOMMENDATIONS

1. Early investigations of potential hydroelectric power in Burma by B. Raikes are summarized in Table XIX–1. The prewar and existing power system are detailed in Table XIX–2 indicating that much work is yet required to restore prewar facilities and production. In the last column of the table is given the estimated future demand based on the statements of local business men and power plant operators. These are long range needs predicated on requirements for electrification of existing enterprises and substantial lighting and water supply installations. Table XIX–3 contains the "build-up" for the estimated future demand.

2. A plan for immediate expansion of the existing power system by installation of new diesel and hydroelectric facilities in 36 towns has been prepared by the Electricity Supply Board. The construction would require about three years. It will assist in early completion of several portions of the longer range developments presented in this Report without appreciable waste of labor and materials, and is endorsed as meriting approval and prompt implementation.

TABLE XIX – 32

ESTIMATED ENERGY USE AND PEAK DEMAND, 1961

District or State	Million kWh/Year			Assumed Load Factor	Peak Demand kW	Proposed Installation		
	Domestic	Bulk	Total			kW	Type	Location
Arakan Division								
Akyab	6·8	139·4	146·2	47·0	41,000	60,000	Hydro	Saingdin
Kyaukpyu	0·5	2·9	3·4	30·0	1,300	2,000	Diesel	Kyaukpyu
Sandoway	0·5	0·4	0·9	20·0	500	800	,,	Sandoway
Pegu Division								
Pegu	2·8	12·0	14·8	28·0	6,000	*30,000	Steam	Rangoon
Hanthawaddy	1·9	9·5	11·4	28·0	4,700	45,000	Hydro	Pegu River
Insein (rural)	0·8	5·5	6·3	25·0	2,600	†40,000	,,	Paunglaung
Rangoon–Insein	50·0	90·3	140·3	42·2	38,000	(Pegu–Rangoon Loop)		
Tharrawaddy	2·7	4·7	7·4	28·0	3,000			
Prome	2·6	3·3	5·9	25·0	2,700	Satthwa–Prome–Letpadan Line		
Toungoo	2·6	4·3	6·9	25·0	3,200	Paunglaung–Pegu Line		
Irrawaddy Division								
Bassein	3·8	7·6	11·4	25·0	5,200	Henzada–Bassein Loop		
Henzada	3·3	17·2	20·5	28·0	8,400	Spur from Pegu–Rangoon Loop		
Myaungmya	2·1	4·4	6·5	25·0	3,000	Henzada–Bassein Loop		
Maubin	2·0	4·4	6·4	25·0	2,900	,,	,,	,,
Pyapon	2·0	4·4	6·4	25·0	2,900	,,	,,	,,
Tenasserim Division								
Amherst	3·7	9·1	12·8	28·0	5,200			
Thaton	2·6	3·9	6·5	25·0	3,000	16,000	Hydro	Lampha Ch.
Tavoy	1·4	16·5	17·9	50·0	4,100			
Mergui	1·4	1·5	2·9	20·0	1,700	2,000	Diesel	Mergui
Magwe Division‡								
Magwe	2·4	28·4	30·8	60·0	5,900	*11,300	Steam	Chauk
Minbu	1·4	1·8	3·2	25·0	1,500	*11,300	,,	,,
Thayetmyo	1·4	5·5	6·9	60·0	1,300	*1,600	,,	Thayetmyo
Pakokku	2·1	4·3	6·4	25·0	2,900	Spur from Myingyan–Mand. Loop		
Mandalay Division								
Mandalay	10·6	12·7	23·3	30·0	8,900			
Kyaukse	0·6	0·7	1·3	21·0	700	30,000	Steam	Myingyan
Meiktila	1·3	3·2	4·5	26·0	2,000	†40,000	Hydro	Paunglaung
Yamethin	1·9	12·2	14·1	22·0	7,300	(Myingyan–Mandalay Loop)		
Myingyan	2·4	110·2	112·6	50·0	25,700			
Sagaing Division								
Sagaing	1·5	3·4	4·9	21·0	2,700	Spur from Myingyan–Mand. Loop		
Shwebo	1·5	3·4	4·9	20·0	2,800	Mu River Loop		
Myitkyina	1·1	2·3	3·4	20·0	1,900	2,500	Diesel	Myitkyina
Bhamo	0·6	1·3	1·9	20·0	1,100	1,500	,,	Bhamo
Upper Chindwin	0·7	11·2	11·9	50·0	2,700	6,000	Steam	Kalewa
Lower Chindwin	1·9	2·6	4·5	20·0	2,600	Mu River Loop		
Katha	1·5	1·3	2·8	20·0	2,200		,,	,,
Eastern States								
Northern Shan States	2·4	52·8	55·2	60·0	10,500	§12,000	Hydro	Namsan
Southern Shan States	2·8	53·8	56·6	60·0	10,800	18,000	,,	Loikaw
Kayah State	0·6	7·2	7·8	40·0	2,200			
Total	132·2	659·6	791·8		235,100	318,700		

* Existing steam plants.

† Paunglaung to have 80,000 kW capacity by 1962.

‡ Myingyan–Magwe–Pyinmana transmission line to be constructed about 1960 will bring cheap power to Magwe Division.

§ Existing hydro supplemented from Mandalay–Lashio transmission line.

3. Three large power plants for immediate development are discussed in detail. The market estimates are based on planned industrial expansion near each of the three developments and the improved standards of living and power use always attendant on such expansion. These estimates are lower than those given in Tables XIX-2 and XIX-3 but will closely coincide if the growth trend is extended for another ten years. It is significant that the local people in central Burma are demanding more electric power than the contemplated program will provide in the near future, if the industrial projects are completed on schedule. For example in the lower Pegu division and Henzada the reported demand totals about 75,000 kW including the proposed steel mill and irrigation pumping, whereas the proposed supply will be 60,000 kW in 1957 and 75,000 kW in 1960, leaving no spare capacity whatever. In the Mandalay Division and Sagaing Town the reported demand totals about 45,000 kW including the proposed Myingyan zinc plant, whereas the proposed supply will be 30,000 kW in 1957 and 40,000 kW in 1962. It is apparent that a sizable market exists which will largely absorb the output of the proposed power stations without regard to the early completion of major industrial projects such as the steel mill or the zinc reduction plant.

4. Preliminary studies and physical data for each of the three power plants are included together with the estimated construction costs and costs of power production. A plan of implementation is included covering immediate field investigation and design plus near future construction to be completed in 1956 for the steam plant and 1957 for the two hydroelectric plants. Early construction of those power plants is recommended subject to thorough field investigation of each project to indicate the soundness of the adopted design.

5. A plan for extension of the proposed Kalewa mine power plant and transmission system to supply neighboring communities is described. Such an extension is recommended in order to widen the markets and usefulness of this power plant.

6. Other hydroelectric plants recommended for continued investigation and probable future construction are the following:

a. Paunglaung River near Pyinmana
b. Balu Chaung near Loikaw
c. Bawgata Chaung near Kyaukkyi
d. Lampha Chaung (Moulmein supply)
e. Namtu River, Pyaungsho Rapids
f. Mu River dams and canal (proposed irrigation system)
g. Namsan Falls plant, Namtu (expand)
h. Hpaungdaw plant, Tavoy (expand)
i. Mogok hydroelectric plant (expand)

The Paunglaung project should be given first priority in view of its accessibility and usefulness in serving large potential markets. The Balu Chaung project should be given high priority as a source of low cost power for the Kayah and southern Shan States including the proposed Lough Keng zinc development.

7. The proposed transmission system shown on Plate 1 includes an initial loop serving Pegu, Rangoon and Henzada, a second loop in the Mandalay Division, and a line from Saingdin Falls to Akyab and the proposed paper factory. Expansion of the initial system will require construction of the Paunglaung hydroelectric plant and the Sittang Valley line from Yamethin to Pegu. The following additional transmission lines are proposed:

a. Myingyan, Chauk, Magwe, Pyinmana
b. Satthwa, Prome, Letpadan
c. Henzada, Bassein, Maubin, Rangoon
d. Payagyi, Thaton, Moulmein, Tavoy
e. Myingyan, Ye-U, Shwebo, Sagaing
f. Ye-U, Wetto, Katha
g. Mandalay, Maymyo, Lashio
h. Mawchi, Loikaw, Taunggyi, Lough Keng
i. Loilem to Mao Pang hydro station (future)

Items a, b and c should be given top priority in order to bring low cost hydroelectric power to the central Irrawaddy and Delta markets in the near future.

8. Diesel plants are proposed for remote towns as a permanent supply, subject to a review of the local hydroelectric resources in each case. It is recommended that the diesel installation be enlarged when necessary by the addition of units made available from the central Burma power system.

9. Stream flow measurements and supplemental rainfall measurements for hydro-power purposes should be systematically collected, published and distributed to the several government agencies engaged in planning and construction of river projects. It is recommended that the function be assigned to the Electricity Supply Board, or to the Irrigation Department, or to the proposed new Ministry of Engineering Services (see par. A.3 of Chapter XXV).

PART VII

INDUSTRY

CHAPTER XX

INTERRELATION OF INDUSTRIES

A. RANGE OF INDUSTRIES

The industries to be considered in the economy of Burma range from small scale to large scale, from extractive to manufacturing, and from state owned to privately owned. The mineral industries and forest industries described in Chapters XXI and XXIV, respectively, are both extractive and manufacturing in nature. Their prominence stems partly from the fact that they exploit some of the raw materials which are sources of the country's economic independence. The manufacturing industries treated in Chapter XXII and the small scale industries discussed in Chapters XXIII and XXIV contribute the large body of productive enterprise required to free essential consumer products from the burden of round-the-world shipping costs and to provide support to each other and to other projects of the development program.

B. COMMON ECONOMIC FACTORS

1. PUBLIC AND PRIVATE CORPORATIONS

Both government and private initiative are important to accelerated industrial development. Government operations have the advantage that centralized planning affords in meeting recognized needs with scaled remedial measures, but are limited by the rigidity and inertia of centralized administrations which cannot respond, expand, multiply, or contract freely with changing local conditions. Private initiative enjoys the converse characteristics in that it responds spontaneously to favorable conditions, and exploits automatically the latent managerial and promotional talents scattered throughout the population. The program presented here contemplates the optimum utilization of both public and private productive resources.

2. EXPANSION EFFECTS

The expansion of trades, services, handicrafts and small scale industries can be expected to develop in some measure spontaneously in response to the implementation of tax, tariff, credit and marketing policies recommended elsewhere in the Report. Their further expansion depends upon the introduction of cooperative enterprises, educational programs, extension services and facilities for obtaining equipment. In these fields lies much of the "slack" in the economy which will be taken up by the first manifestations of increased consumer purchasing power.

At a casual glance, the interdependence of various industries and services would seem to deny the possibility of finding a starting point for development. Each industry appears to depend upon some other for one or more key elements, and all depend upon improved transport, communications, economic policies, and trained specialists in order to get off to a healthy start. If the program had to be undertaken in isolation from the rest of the world, the difficulties could not be overcome for many years. Fortunately, however, Burma's favorable foreign exchange balance permits the purchase of both services and capital resources from outside. When a start has been realized in enough industries, a regenerative cycle or "chain reaction" should reduce materially the requirement for further contributions from overseas.

3. SELECTION

More directly, many specific industries and some improved living factors will depend entirely upon other industries for either raw materials or finished products. In the succeeding chapters, therefore, projects recommended for early action have been selected not only for economic feasibility but for their mutually complementary nature or because they would immediately satisfy a grave consumer need. General industrial projects have been grouped into a First-Year Plan, an Intermediate Plan, and a Long-Range Plan (see Section D, Chapter XXII).

C. COMMON REQUIREMENTS

1. RESOURCES

Basic requirements for most of the projects discussed in the succeeding chapters are electric energy and a fuel supply both adequate in quantity and reasonable in unit cost. Provisions for meeting these requirements are developed in Chapters XIX and XXI, respectively, Another essential to the success of the program is experienced management and operating personnel to assist in construction and operation of plants and projects. Ways and means of meeting this requirement are outlined in Chapters VII and XXV.

Other resources required by industry include the raw materials, minerals, and agricultural products required by each industry appropriate to its nature. Some of these will be locally available. Some must be imported.

2. STEPS IN IMPLEMENTATION

To initiate and bring into operation an industrial project in such a way as to insure that it will be sound economically, administratively, and functionally, it is necessary that the project evolve through successive stages of maturity.

a. Preliminary Plans

Preliminary plans, sometimes parts of master plans, are generally prepared from scanty data. They may or may not be based on data sufficiently reliable to guarantee feasibility of the project. The elements of this comprehensive Report are in the preliminary planning class.

b. Investigations for Design

Before funds for other than investigational purposes are committed, sufficient additional data should be obtained to leave no doubt as to feasibility. Such data should confirm necessary resources and marketing estimates, confirm suitability of site and access to the site, establish a feasible management and operating plan, and confirm the feasibility and costs of plant design and construction. If only a little additional information is required and can be obtained by existing agencies, and if the information confirms feasibility, the design organization can be selected. If more information is required, a planning and investigations group may have to be assembled to obtain it.

c. Designs and Specifications

When decision has been made to proceed with the project, the agency that is to detail the designs and specifications and supervise construction must be selected. At the same time, existing agencies may proceed with such collection of detailed data as can be anticipated. Upon establishment of the design agency, that agency must be given expedited support in assembling such additional data as it may require.

The design organization will need to have foundation information, hydrographic and climatic information, sources and costs of materials, transport facilities, and complete information on raw materials and marketing problems. If field investigations are to be extensive, they should be supervised by field forces of the design and construction organization.

d. Construction and Operations

Depending upon the nature of the project, the design organization may or may not be the same organization that will construct or that will operate the completed plant. These decisions can probably be made early and largely on the basis of information contained in this or various project reports, supplemented by any additional data that may be required.

The design organization should in any event supervise the erection of the plant whether constructed by contract or otherwise. It should also specify, approve, inspect, and test equipment to be purchased or erected and installed. Specifications for equipment must be as carefully drawn and rigidly correct as for any part of the works.

Operations may be performed by management contract with a different firm from the design firm, with the same firm, or with trained Burmese personnel if available. Contractual arrangements should be explicit with respect to requirements for training the permanent operating staff. Other more general criteria for proper implementation of projects are cited in Chapter XXV.

CHAPTER XXI

MINERAL INDUSTRIES

A. GENERAL GEOLOGY

A thorough knowledge of the general geology of any country is essential to the successful exploration, evaluation and development of its mineral resources. Although the knowledge attained to date in Burma is considerable, it is far from thorough or even adequate. Accurate geological mapping, the basis of all other geological work, has covered comparatively little of the whole area of the country.

The four principal physiographic provinces are the central basin, the Arakan Yoma, the Arakan coastal strip, all extending in a north–south direction, and in the east the Shan Plateau extending southward to include the Tenasserim mountain ranges. There are five recognized tectonic lines which are the major structural features. All have a north–south trend. Intrusive magmas have followed these lines of weakness in the earth's crust, and the metallic ore deposits associated with or closely connected with the intrusives have been governed and localized by them. In the west the intrusives generally vary from ultrabasic to basic while in the east they are acidic.

Field work undertaken during the course of the present survey at Kalewa, in the Naga Hills tract, in the southern Shan State, the Kachin State, the Kayah State and the Tenasserim Division have contributed to a better knowledge of these mineralized areas. The additional information developed may be found in the several development project and field examination reports previously submitted.

B. ECONOMIC GEOLOGY

1. MINERAL OCCURRENCES AND DEPOSITS

Listed alphabetically hereinafter are the principal minerals, or metals obtainable therefrom, known to occur in Burma. Excluded are radioactive and rare earth minerals; included are amber, coal and petroleum, sometimes not classified as minerals within the specialized meaning of the word. Aggregates of minerals comprising building material and road metal are mentioned separately. Reference may be made to the Preliminary Report for the location of most of the better known or more important occurrences and deposits. Those having present or potential economic importance are discussed briefly under the next subheading.

Minerals known to occur in Burma

Alum
Amber
Antimony
Barite
Bauxite
Beryl
Bismuth
Cadmium
Chromite
Cinnebar
Coal
Cobalt
Columbite
Copper
Corundum
Gem stones
Gold
Graphite
Gypsum
Iridium
Iron ores
Jadeite
Kaolin
Lead
Manganese
Mica
Molybdenum
Natural gas
Nickel
Ochre
Oil
Oil shale
Phosphates
Platinum
Salt
Saltpetre
Silver
Soda
Steatite
Sulphates
Sulphides
Sulphur
Tin
Titanium
Tungsten
Zinc

Granites, gneisses, laterite, limestones, marble, sandstones, serpentines, trap rocks, clays, sands and gravels occur, suitable for building blocks, concrete aggregates, road metal and the manufacture of cement, bricks, tiles, pottery, china and glass.

2. ECONOMIC EVALUATION

Those mineral deposits which until now have proved of greatest economic importance to Burma are notably tin, tungsten, lead-silver, and petroleum. The importance of the few minerals produced with extremely limited and superficial exploration indicates a high probability that the orderly development of Burma's mineral resources can provide in a relatively short time a large measure of the wealth needed to establish other industries and to achieve the improved living standards that the people seek.

Although the exploitation of its oil resources has provided part of Burma's requirements of petroleum products, the coal and coke required to serve its solid fuel requirements have been imported. No effective effort has been made to develop domestic production. During the course of this survey, however, it has been determined that the country has at least one extensive deposit of coal, namely the Kalewa field, which can be developed to supply industrial power and probably railway locomotive fuel for the needs of the country for many years. The exploration work and utilization tests on which this determination is based are discussed in subsequent paragraphs.

The comparatively cheap fuel and electric power which Kalewa coal could furnish would provide an essential economic base for the establishment of new industries and the expansion of existing ones. For instance, the establishment of an electrothermic zinc refinery would become possible. In turn this would make possible the exploitation of the Lough Keng zinc deposit and the export of zinc metal instead of only concentrates and ore.

Although many of the minerals and metals listed under the preceding heading are not known to occur in quantities or concentrations sufficient to make their development and exploitation economically feasible, the discovery in certain instances of deposits which are of economic value is by no means precluded. On the contrary such discovery is likely if an orderly continuing program of exploitation and development is adopted and executed. Undoubtedly such a program would bring in new sources of antimony, manganese, tin, tungsten, lead and zinc production.

It is certain that the known reserves of oil can be extended and that increased production can be developed if Burma's domestic and export demands require it. In general, the evidence is overwhelming that Burma's mineral resources are greatly under-explored and under-developed.

C. ESTABLISHED MINERAL PRODUCTION OPERATIONS

1. BURMA CORPORATION (1951) LIMITED

The Preliminary Report stated that the Corporation planned to resume operations at the monthly rate of 8,000 tons of ore mined and milled. To date, although noteworthy progress has been made in training indigenous mine labor, only about half this rate has been achieved. Present plans call for expanding the tonnage mined and treated to 25,000 tons per month, this objective to be attained about two years hence.

The treatment of this larger tonnage will require the construction and installation of additional milling facilities to treble the capacity of the present plant. To mine this tonnage will necessitate the recruitment, training and employment of more underground workers to nearly double the force required for a monthly rate of 8,000 tons mined. Bearing in mind the trained mine labor that may also be required for the Kalewa coalfield and the Mawchi mines, it is doubtful whether the supply of indigenous labor will be sufficient to permit the attainment of this objective within two years.

Should this presently proposed production rate be achieved in two years, zinc concentrates could be produced at an annual rate of approximately 66,000 tons as compared with the 22,000 ton rate on which the Myingyan zinc project is based.

2. THE MAWCHI MINES LIMITED

Mawchi mines lies in territory that continues to be held by insurgents. Any quantities of tin and tungsten concentrates being produced are believed to be comparatively small and derived from the illegal working of scattered surface occurrences rather than from the mine proper. Such production is presumably transported illegally into Thailand. Efforts to regain control of the Mawchi area by the end of the current dry season were unsuccessful.

3. THE PETROLEUM INDUSTRY

During the several years prior to the last World War, the annual production of petroleum in Burma was stabilized at about 275,000,000 Imperial gallons, including about 10,000,000 gallons of petrol derived from natural gas. Some 70% of the liquid products were exported to India. Additionally, wax was made into candles for domestic consumption and exported in bulk to India and the United Kingdom.

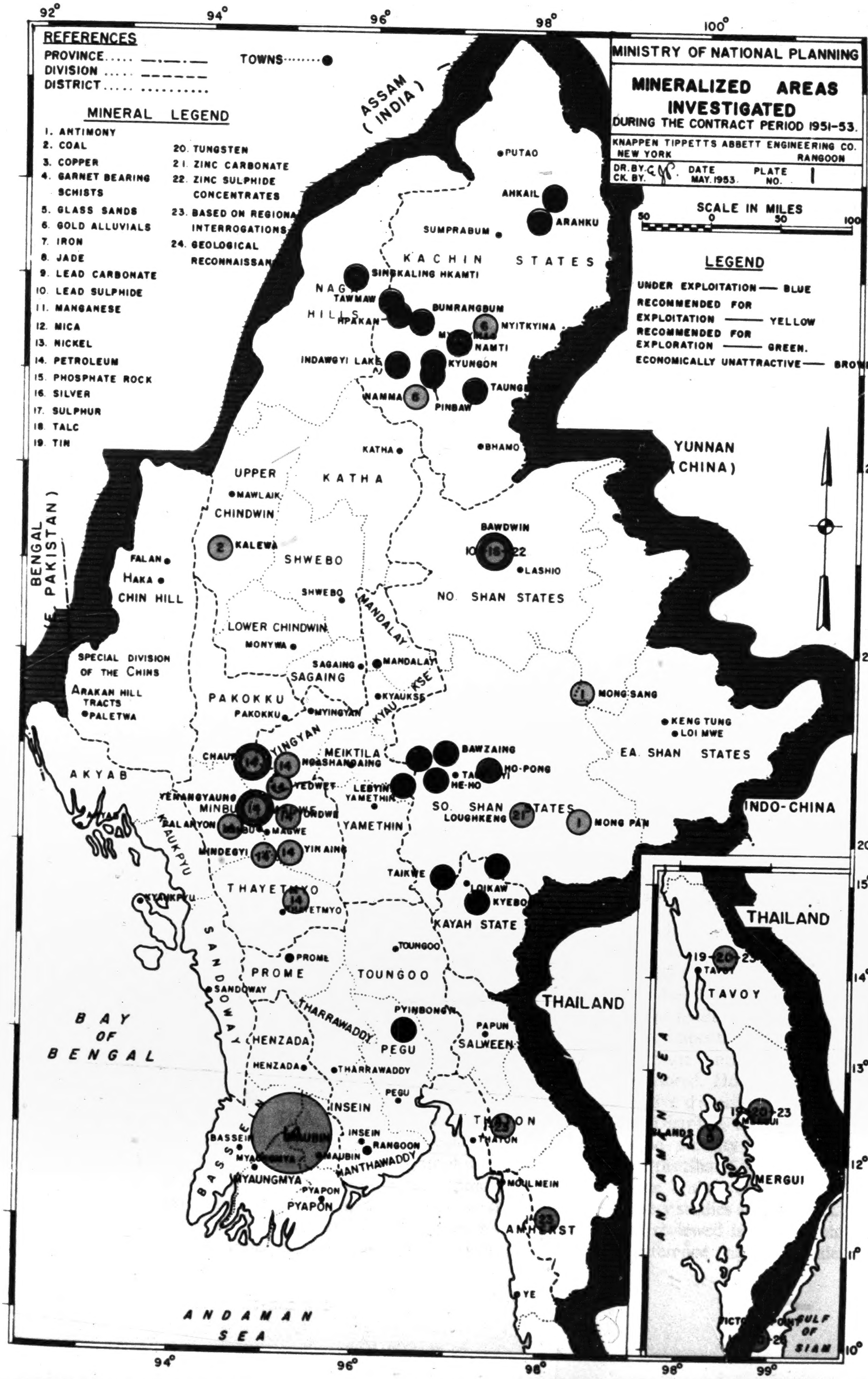
Although small compared with the output in many other countries, the production provided Burma with a prominent source of employment, internal revenue and foreign exchange. At prices prevailing during the few years prior to the war, the crude oil produced was valued at about K6,00,00,000 and the products refined therefrom in Burma were valued at about K15,00,00,000

The Burmah Oil Company, Indo-Burma Petroleum and British-Burma Petroleum controlled some 97% of the prewar output, the balance being distributed among several local companies. During the war the properties of the oil companies suffered extensive damage. To achieve a more effective program for rehabilitation of the industry, the three large companies combined their production and refining holdings as the Associated Oil Companies, referred to elsewhere in this chapter. In this group BOC ownership represents 76·8%, IBPC 17·0%, and BBPC 6·2%.

The Associated Oil Companies resumed production in January 1947. Although rehabilitation was and continues to be seriously interrupted by the insurrection, a production of 25,800,000 gallons of crude was obtained in 1952. Insofar as the known and potential reserves of oil are concerned, the industry is capable of noteworthy expansion whenever economic conditions warrant and civil conditions permit.

4. GENERAL

Security conditions have continued to affect adversely the tin and tungsten mining operations in the Tenasserim Division and in the Pyinmana and



MINISTRY OF NATIONAL PLANNING

MINERALIZED AREAS INVESTIGATED DURING THE CONTRACT PERIOD 1951-53.

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. C.G. CK. BY. DATE MAY. 1953. PLATE NO. 1

SCALE IN MILES
50
0
50
100
LEGEND
UNDER EXPLOITATION —— BLUE
RECOMMENDED FOR EXPLOITATION —— YELLOW
RECOMMENDED FOR EXPLORATION —— GREEN.
ECONOMICALLY UNATTRACTIVE —— BROWN.
REFERENCES
PROVINCE ..... —·—·—
DIVISION ..... — — — —
DISTRICT ....
TOWNS .... ●
MINERAL LEGEND
1. ANTIMONY
2. COAL
3. COPPER
4. GARNET BEARING SCHISTS
5. GLASS SANDS
6. GOLD ALLUVIALS
7. IRON
8. JADE
9. LEAD CARBONATE
10. LEAD SULPHIDE
11. MANGANESE
12. MICA
13. NICKEL
14. PETROLEUM
15. PHOSPHATE ROCK
16. SILVER
17. SULPHUR
18. TALC
19. TIN
20. TUNGSTEN
21. ZINC CARBONATE
22. ZINC SULPHIDE CONCENTRATES
23. BASED ON REGIONAL INTERROGATIONS
24. GEOLOGICAL RECONNAISSANCE
92°
94°
96°
98°
100°
28°
26°
24°
22°
20°
ASSAM (INDIA)
PUTAO
ANKAIL
ARAHKU
SUMPRABUM
KACHIN STATES
SINGKALING HKAMTI
NAGA HILLS
TAWMAW
HPAKAN
BUMRANGBUM
MYITKYINA
NAMTI
INDAWGYI LAKE
KYUNGON
TAUNGE
NAMMA
PINBAW
KATHA
BHAMO
YUNNAN (CHINA)
UPPER CHINDWIN
MAWLAIK
KATHA
BENGAL (PAKISTAN)
FALAN
HAKA
CHIN HILL
KALEWA
SHWEBO
BAWDWIN
10-16-22
LASHIO
NO. SHAN STATES
SHWEBO
MANDALAY
LOWER CHINDWIN
MONYWA
SPECIAL DIVISION OF THE CHINS
ARAKAN HILL TRACTS
PALETWA
SAGAING
MANDALAY
SAGAING
PAKOKKU
KYAUKSE
PAKOKKU
MYINGYAN
MONG SANG
KENG TUNG
LOI MWE
EA. SHAN STATES
CHAUK
MYINGYAN
MEIKTILA
BAWZAING
HO-PONG
TAUNGGYI
HE-HO
LEBYIN
YAMETHIN
AKYAB
YENANGYAUNG
MINBU
YEDWET
SO. SHAN STATES
LOUGHKENG
MONG PAN
INDO-CHINA
KYAUKPYU
BALARYON
MAGWE
MINDEGYI
YIN AING
YAMETHIN
TAIKWE
LOIKAW
KYEBO
THAYETMYO
THAYETMYO
KAYAH STATE
KYAUKPYU
SANDOWAY
TOUNGOO
PROME
PROME
TOUNGOO
SANDOWAY
THAILAND
BAY OF BENGAL
THARRAWADDY
PYINBONGYI
HENZADA
PEGU
PAPUN
SALWEEN
HENZADA
THARRAWADDY
PEGU
INSEIN
BASSEIN
MAUBIN
INSEIN
RANGOON
THATON
THATON
MYAUNGMYA
HANTHAWADDY
MOULMEIN
PYAPON
AMHERST
YE
ANDAMAN SEA
THAILAND
19-20-23
TAVOY
TAVOY
ANDAMAN SEA
19-20-23
MERGUI
MERGUI
VICTORIA POINT
GULF OF SIAM
15°
14°
13°
12°
11°
10°
98°
99°
1
2
5
6
14
21
22
23
24

Yamethin areas. Until there is assurance of an enduring major improvement in these conditions, little if anything can be done to implement recommendations for more effective exploration, development and production. Recommended modifications of mining legislation and taxation could, however, be effected in the interim.

D. FIELD EXAMINATIONS, STUDIES AND INVESTIGATIONS

1. GENERAL

All of the recommendations of the Preliminary and Interim Reports were related to projects or activities designed to develop the country's mineral resources. Most of them entailed field examinations and surveys, explorations, laboratory investigations, metallurgical tests, economic evaluation studies, and the formulation of development and exploitation programs. The principal areas investigated are indicated on Plate 1. Despite increased difficulties arising from civil and security conditions, important results were achieved as hereinafter summarized.

2. THE MINERAL RESOURCES DEVELOPMENT CORPORATION

Following the examination and study of development corporations in other countries by a Burmese Mission sent overseas for this purpose, enabling legislation was drawn up and passed by Parliament as GUB Act No. 44 of 1952 to create "The Mineral Resources Development Corporation." The Act specified the Corporation's constitution, powers and functions, and financing and accounts; specified its powers to establish subsidiary corporations; defined its general legal status; and established it as a legal entity as from November 1, 1952. The stipulated directorate, including a Director-General, was appointed, and the recruitment of administrative, technical and operating personnel was begun.

3. INVESTIGATION OF THE KALEWA COAL FIELD POTENTIALITIES

Pursuant to the recommendations made in the Preliminary Report for further field and laboratory investigation of the Kalewa coal field, GUB Project Proposal No. 61, "Kalewa Coal Development Preliminary Field and Laboratory Investigation" was drafted, approved by BEAC and TCA, funds allocated by the latter, and execution finally assigned in February 1953 to Pierce Management Inc. of Scranton, Pennsylvania. Most of the equipment required for the project has arrived in Burma, a bulldozer for the construction of access roads having arrived at Kalewa. Some access roads to diamond drilling sites have meanwhile been under construction, the services of two bulldozers having been obtained for this purpose from the Public Works Department. The Project Manager arrived in Burma on March 29 and the foreign drilling personnel required are expected shortly.

Meanwhile, the prospect shaft at Kalewa was deepened, and bulk coal samples secured for shipment to the United States and Germany for low carbonization, briquetting and other utilization tests. Approximately 4,500 pounds of Kalewa coal were shipped to the United States for this purpose and 2,000 pounds to Germany. From the tests conducted in the United States, bulk samples of briquettes were received in Burma and used for combustion tests on a Burma Railways locomotive with satisfactory results. Commercial scale briquette manufacturing tests and the return to Burma of several tons of briquettes for full scale locomotive tests are part of the program of Project No. 61.

The continuing studies and investigations in Burma and in the United States will furnish the data for detailed plans and specifications for the development of the coalfield. Studies of consumer demand indicate that the mine should be developed to supply annually 400,000 tons of Kalewa coal products to meet solid fuel requirements for transport, power, industrial and metallurgical uses. The development plan and all relevant data obtainable to date have been incorporated in a Kalewa coalfield development project which is summarized in paragraph E-9-a. For the many details not covered in this summary, reference should be made to the project report itself.

4. THE ANTIMONY PROJECT

The development of a "demonstration mine," and five other mines to be patterned thereon, was a basic recommendation of the antimony project presented in the Preliminary Report. Following the examination of some 20 known occurrences of antimony ore, eight to ten were to be selected for exploration and prospecting to determine the best six. Accordingly, detailed field examinations were made of Mong Sang and Lebyin, two of the most important antimony-producing areas in the Shan State, and a third area near Mong Pan was reconnoitered. However, some of the reportedly most attractive deposits in Burma, in the Thaton and Amherst Districts, remained inaccessible because of adverse security conditions. Samples of antimony ore from the Shan State deposits were despatched by air to the United States where they were subjected to laboratory studies and analysis. The results of this work are reviewed in paragraph E-9-e. For greater detail, reference may be made to the field examination reports and the antimony project as presently revised, reported separately, and summarized in paragraph E-9-e.

5. THE MYINGYAN ZINC PROJECT

The Lough Keng zinc carbonate ore deposit, essential to the Myingyan zinc project, was examined and a report submitted. Representative samples of ore were despatched by air to the United States for analysis and metallurgical investigation. Similarly despatched were samples of Burma Corporation (1951), Ltd., zinc sulphide flotation concentrates. All relevant data including statements and opinions regarding the long term availability and estimated cost of raw materials, notably ore, concentrates and coal; estimates of transportation costs; data on the utilization of Kalewa coal; smelter schedules; and world zinc markets and prices have been carefully studied in the light of the most recent metallurgical developments in the smelting and refining of zinc. Although it has not yet been possible to obtain the detailed topographic, hydrographic and other survey data necessary to permit determination of the best plant site at Myingyan, an initial field examination of the possibilities offered was made in May, and aerial photographs for topographic mapping purposes have been taken. Further mapping progress awaits execution of the ground control required for photogrammetric purposes.

The results of the foregoing investigational activities are reviewed hereinafter beginning with paragraph E-9-b. Subject to final confirmation by large scale furnace tests for which appropriate tonnages of raw materials must be sent to the United States, the establishment of a zinc refining industry using the Sterling electrothermic process is recommended. For greater detail, reference should be made to the Myingyan zinc project report.

6. AREAL DEVELOPMENT PROJECTS

Throughout the period under review field investigations were generally restricted by security conditions, and, with few exceptions, were precluded in the Tenasserim Division, a large part of the Kayah State, and the Yamethin District.

a. Shan, Kayah and Keng Tung States

In the Shan State, examination of the Lough Keng zinc carbonate deposit confirmed the existence of 550,000 metric tons of measurable outcrop ore with an average content of 40% zinc. Assays and metallurgical tests of ore samples sent to the United States confirmed that the ore would be amenable to treatment by the electrothermic process recommended for the Myingyan zinc refinery. The visible ore alone is sufficient to supply the refinery's needs for zinc carbonate ores for over 15 years without taking into account possible downward extensions.

Plans for underground exploration designed to determine by hand method downward extensions of the carbonate ore and its possible transition at moderate depth into sulphide ore were prepared and submitted, together with cost estimates, to the Mineral Resources Development Corporation. The execution of this program will determine whether diamond drilling may be required later to disclose fully the extent and physical characteristics of the ore body.

Estimates were made of the cost of a 25–30 mile access road from Mong Pawn to Lough Keng and of the cost of equipping the property for the surface mining and transport to railhead of 40,000 tons of ore annually for 15 years. Aerial photographs were taken for topographic mapping purposes, for road alignments, and for use in the geological survey to be made in connection with the exploration program, and the ground survey control for photogrammetric measures is presently awaited.

Lead sulphide and carbonate ore occurrences and mining operations in the Bawzaing–Mawson, Allegyaung and other areas were examined. Because of lack of facilities the lead carbonate zone south of Mawson has not yet been prospected and tested as recommended in the Preliminary Report. Apart from this development possibility, no deposits of major economic importance were encountered or indicated. The principal manganese deposit in the Ho Pong area was examined, and recommendations for more efficient exploitation were made. Other manganese deposits in the area were examined also, and recommendations made to the owners for prospecting and exploration work where the showings were promising. The field examinations and recommendations are covered in reports previously submitted to Government.

Coal occurrences north and northwest of Taunggyi were investigated. Although some of the coal had been reported to have coking characteristics, test of samples taken did not confirm this. The seams exposed were of trivial thickness and lacking in apparent continuity of strike and dip. The conclusion was reached that economic coal deposits are unlikely to be discovered in the Shan State. Similarly, a coal occurrence at Htai Kwe, a few miles west of Loikaw, and one at Kyebogyi, a few miles north of Bawlake, both in the Kayah State, were examined and found to be of no importance.

Antimony deposits at Mong Sang and vicinity, and at Mong Pan were examined. The former was found sufficiently promising to justify a considerable program of exploration and development. On the other hand, the Lebyin mine, referred to in the Preliminary Report, was examined in detail, and the conclusion reached that it showed little if any promise.

Several occurrences of copper ore were examined in the Shan State, but none of them appeared to be promising. The occurrences reported south of Heho on the east side of Inle Lake remained inaccessible for examination because of security conditions. Although the reported occurrences of phosphate rock in the Kayah State which were examined and sampled were disappointingly low in content additional exploration appeared warranted.

Such information regarding the mineral potentialities of Keng Tung State as could be obtained from interrogating the best informed persons in Keng Tung was recorded for future reference. Although it was impossible under the circumstances to reconnoitre outside of the town of Keng Tung, it is believed that the Wah States may prove, on exploration, to have worthwhile deposits of lead and antimony ore, and that south and west of Keng Tung, along the Thai border, there may be economically attractive deposits of tungsten.

b. The Kachin State and Naga Hills

In the Kachin State, the highly reputed lead-silver ore deposit at Arahku was examined as well as a reported copper-nickel deposit at Ahkail, north of Arahku. This examination trip required considerable organization because of the lack of communications, Arahku being approximately 12 days by trail from Sumprabum. The deposit at Arahku proved disappointing and that at Ahkail valueless. Following the initial examination of Arahku, approximately 100 ft. of underground exploration was accomplished. This effectively demonstrated that the Arahku occurrence possessed no potential economic value and that further efforts to develop it should be abandoned.

An examination visit to the lead-silver deposits in the vicinity of Putao, which because of the greater local interest in Arahku had been assigned second priority, was started but abandoned prior to completion when the examining engineer was recalled to Rangoon by Government.

In addition to these two principal investigations, showings of copper ore at Taungbalom; gold alluvials at Myitkyina, Namma, Hpakan on the Uru River and in Nanpanmwe Chaung; iron and sulphur showings at Indawgyi Lake; coal occurrences at Pinbaw; talc occurrences near Kyungon; jade showings and workings on the Masa Hka, at Tammaw and Hpankan; garnet-bearing schists of possible commercial value at Namtu near Myitkyina; and mica-bearing formations at Bumarang Bum were investigated by the engineer and his field assistants. None of these occurrences proved impressive except for auriferous gravels at Namma and near Myitkyina where it was recommended that the possibility of a commercial deposit be explored by systematic sampling.

Working from Singkaling Hkamti on the Upper Chindwin River as a base, a geological reconnaissance was made with the assistance of Dr. Ba Thi, acting Director of the Geological Department, of part of the Naga Hill tract to the west of the river and of a smaller strip to the east. As a result, the probability of important mineral deposits to the west was largely discounted.

c. Tenasserim Division

Various deposits of beach sands were examined on Tavoy, King, Tantage and Mergui Islands of the Mergui Archipelago with a view to evaluating them as possible sources of raw material for a glass manufacturing industry. At least one deposit of suitable quality was found, namely, the Thegon and adjoining Panyoyo sands, although the quantity of 27,200 cu. yds. estimated to be available was not as large as desired. It is believed that further examination might discover additional small deposits.

While it was possible to investigate and report to a considerable degree upon the status of the tin and tungsten mining industry in the Tenasserim Division by interrogating owners, operators and government officials at Mergui, Tavoy and Victoria Point, it was impossible, because of lack of security, to make more than a brief inspection of a few tin and tungsten placer areas northeast of Mergui and in the vicinity of Victoria Point. Despite this disadvantage, definite conclusions were reached regarding measures which should be taken to encourage expanded production activities once security conditions become normal. These measures are presented hereinafter in the section dealing with future mineral development.

d. Pegu District

The coal occurrences at Pyinbongyi, some 40 miles north of Pegu were investigated to the extent permitted by security conditions and found to be of a trivial extent and of no economic importance.

7. MINERAL INDUSTRY TRAINING PROGRAM

The manner in which an effective mineral industry training program could be established on a continuing basis was discussed with the Mineral Resources Development Corporation. Specific reference to the program recommended will be found in subsequent sections and on the organization chart submitted to the Corporation.

E. FUTURE MINERAL DEVELOPMENT

1. GENERAL

a. Economic Potentialities

In the fiscal years 1937–1941, mineral exports accounted for 33% of the national total. So far as the deposits exploited during this period are concerned, most of them are still capable of return to the prewar rate of production. With the higher metal prices now prevailing, the value of mineral production would be increased greatly. While there are instances where the prewar production rate could not be maintained for many years from known reserves, there are many other instances in which no systematic effort has been made to develop the deposits to create additional reserves. Also, many of the deposits being exploited before the war are capable of an even higher rate of production if efficient operating methods are used. In important instances, also, the provision of access roads alone would make expanded production operations economically feasible.

An example of a known but undeveloped and unexploited mineral deposit is Kalewa coal. Here development and exploitation would not increase exports, but would reduce and could even eliminate the need for imports and, apart from other economic advantages more important to the country, would result in an appreciable saving of foreign exchange.

Additionally, the exploitation of this source of solid fuel would result directly in an increase in the export of other minerals. With Kalewa coal, the establishment in Burma of a zinc refinery becomes economically practicable and desirable. The zinc refinery would make possible the exploitation of the Lough Keng zinc carbonate ore deposit, which without the refinery would be economically unattractive, and would thus enable the export from Burma of zinc metal. Foreign exchange earnings would thus be increased by both the increase in zinc exploitation and by the substitution of the export of zinc metal for the export of concentrates.

The economic potential in undiscovered mineral deposits cannot be readily evaluated. Considering that such a comparatively small part of the total area of Burma has been explored for mineral deposits, even superficially, and that only two efficiently developed deposits of metallic minerals, namely Bawdwin and Mawchi, have made such notable contribution to the Burmese economy, there is ample reason for believing strongly that the potential is comparatively great.

b. Development Policies

In formulating national policies fundamental to a well-integrated, comprehensive mineral development program, the Government should strive to attain the following important general objectives:

(1) The restoration of established mining operations to their prewar level of production.

(2) The expansion of production operations whenever possible by the use of the most recent and efficient mining methods and metallurgical processes.

(3) The creation of additional reserves from known mineral deposits by systematic exploration, prospecting, and development work based on sound technical advice and geological examination of the deposits.

(4) The construction of access roads, where warranted, for facilitating the execution of (2) and (3).

(5) The development by Government of mineral production from new or hitherto unexploited deposits, and the development of new metallurgical industries where the economic value to the country is demonstrable but where private enterprise or capital cannot be induced to undertake such development or exploitation.

(6) The inauguration and effective execution of a long term continuing program of systematic exploration designed to discover mineral deposits of economic value and to secure their early development and exploitation.

(7) The establishment and maintenance of a long term continuing program for educating and training—in Burma and overseas, as required—the labor, supervisory staff, technological and administrative staff, and personnel needed by the mineral industry (see Chapter III).

(8) Revision of the mining laws and regulations, greatly needed improvements in the administration of the mineral concessions, rules, and modifications in the form of taxation on mineral production so that the search for minerals and their development and exploitation by private individuals will be encouraged rather than discouraged. The contributions of private prospecting are essential in a country having unexplored areas as extensive as those existing in Burma, where coverage in any reasonable period of years would be beyond the capacity of any single government agency or corporation.

Progress towards the attainment of these objectives can be best effected by a combination of private enterprise and government effort, the latter exerted energetically through the media of all departments concerned with the development of mineral resources, but particularly through a strong and efficient Mines Department, an adequately staffed and competent Geological Department, and the vigorous and effective contributions of the Mineral Resources Development Corporation. The functions, responsibilities and administration of these departments and of the Corporation are discussed and correlated in following subsections.

2. MINING LAWS AND TAXATION

The serious inconsistencies between existing mining legislation—inherited as it is from an older and distinctly different social and political establishment—and the new self-determined social and political establishment created by the Burmese people, were noted in the Preliminary Report in which it was recommended that early attention be given this matter and the related subject of mineral industry taxation.

a. Existing Legislation

The principal existing regulations are set forth in the "Burma Metalliferous Mines Manual, 1937," as corrected to May 1, 1941, the "Mineral Concession Rules," and the supplementary manual, "The Burma Mineral Concessions Directions, 1947." Recommendations relating to these regulations and to the principles, concepts and consideration from which they arise have already been presented to Government in a separate study entitled "Recommended Modifications of Mining Legislation and Taxation" to which reference is particularly invited for greater detail than that contained in the subsequent summarization.

At present the lawful conduct of mineral development and exploitation under the two basic documents is effected through the combination of four separate devices: a certificate of approval, a prospecting license, a disc license, and a mining lease. The following comments on each device are pertinent to the recommendations which follow:

(1) The Certificate of Approval is considered to be open to abuses far more damaging than its possible beneficial contribution to the modern development of the mineral industry. It has been used by the financially able, to acquire interests in new prospects or mines without personally contributing financially to the exploration.

(2) The Prospecting License is, in effect, a modified mining permit drawn up for a specific claim or area. Prospecting licenses are issued without uniformity. As in the case of the certificate of approval, it is open to serious abuses. A large proportion of the 1951 mineral production in the Shan States came from operations conducted on claims held only under prospecting licenses, a practice believed general throughout Burma. This is inconsistent with the generally accepted definition or connotation of the word "prospecting." and constitutes an effective impediment to that activity as usually understood.

(3) The Disc License is evidently designed to permit an individual of reduced means to conduct small-scale hand method mining operations on "Special Mining Area," By implication and practice it appears to convey the right to mine tin and tungsten deposits only.

(4) The Mining Lease is the basic requirement for lawfully working a mine or exploiting a mineral deposit. It is apparent, however, that despite this legal requirement a very considerable proportion of current mineral production results from operations conducted under certificates of approval, prospecting licenses, and disc licenses, This may be due in part to the fact that present procedures for obtaining a mining lease are unnecessarily complex, cumbersome, and time-consuming. A lease generally denotes the grant by the owner of the right to occupancy and use.

b. Recommended Revisions

The primary modifications of existing mining legislation and mineral industry taxation believed necessary and recommended in a previous report in order to provide a sound base for a modern, equitable, and more effectively workable mining code are as follows:

(1) The principle should be established that the mineral resources of the Union of Burma, in the broadest scope of the term, belong ultimately to the people of the Union, and that the rôle of the Government shall be that of custodian of these resources, as agent by the free will and in the interest of all the people. Government shall by this enactment revoke the principle of its hereditary or ultimate ownership of all mineral resources, except that through lawfully created agents such as corporations, authorities or boards, government ownership of partial to complete interest in specific operating elements of the economy may be acquired by due process of law.

(2) The right to travel freely over the surface of the country where such travel does not involve trespass on notified areas, searching for and examining natural outcrops of rock and collecting specimens and samples of such outcrops for subsequent examination and analysis, where such collection does not involve damage greater than the trivial removal of brush and soil, should be established as a basic free and inalienable right of every citizen of the Union, provided that the Government, acting for and with the consent

of the people, may by prior notification and demarcation, prohibit such travel and search on or within specified distances of areas or establishments created or maintained in the interest of public welfare.

(3) The rules requiring a certificate of approval before issuance of a prospecting license or mining lease should be revoked, and this device should be abolished.

(4) The prospecting license should be revoked and provision should be made for the issuance of a mineral exploration license valid for one year which would entitle the holder to the right of annual renewal for two successive years, prior to the expiration of which the holder would have to make application for a mineral exploitation license if he desired to exploit the deposit.

(5) The device known as the disc license should be abolished and certain advantages which it offers, as discussed in the separate report, should be incorporated in the mineral exploitation license.

(6) The mining lease should be revoked and its broad principles embodied in a new device to be known as the mineral exploitation license, but modified appropriately to (*a*) simplify and facilitate application and issue; (*b*) reduce the land area lawfully to be held under it; (*c*) allow the exploitation of all minerals whenever and wherever found in the licensed area; (*d*) provide for appropriate government revenue by a schedule of reasonable taxes levied on net income or profit derived from the production and disposal of mineral products, at the same time abolishing existing royalty, export and sales forms of taxation; (*e*) provide for termination of the license under certain conditions such as failure diligently to exploit the holding. These recommendations are presented in greater detail in the previously mentioned report. It is worth emphasizing here, however, that the fundamental change in concept in this latter instance should be that the State should derive reasonable revenue from profits made on the sale and disposal of minerals and metals after they have been produced, but not from the rights of the citizens to search for, develop or produce them.

Detailed implementing, clarifying and facilitating enactments will of course be required.

c. Anticipated Procedure

In idealized outline, prospecting, mineral exploration, and exploitation under a code based on these recommendations would develop as follows:

(1) Burmese nationals would exercise their right of free travel and search for promising mineral showings.

(2) If and when such showings were found, a mineral exploration license permitting concentrated exploration, development, and limited small-scale production for renewable periods of one year over a total period of three years, would be readily obtainable.

(3) If the property demonstrates further exploitation potentialities, application for a mineral exploitation license could be made by the holder of the mineral exploration license at any time prior to expiration of the latter. If granted, the exploitation license would permit the licensee to continue exploration and to undertake formal exploitation of his deposits for a maximum period of 25 years.

d. Provisions for Foreign Capital

So far, the recommendations summarized in the preceding paragraphs have applied to the development and exploitation by Burmese nationals, and by the Mineral Resources Development Corporation only. However, for a very considerable period in the future, satisfactory progress toward optimum development of mineral resources will also require foreign enterprise and capital. Foreign capital will not ordinarily seek employment in Burma unless the rights to recover and remove the investment from the country with a fair return thereon are fully assured and protected by law. Indeed, private foreign capital, or even public foreign capital is likely to be made available only in those countries which by reputation and history of fair dealing provide assurance that there will be no confiscation by taxation or by imposition of import, export, and foreign exchange restrictions, or otherwise. The enactment of a mining code should therefore include appropriate safeguards for foreign capital.

3. THE MINES DEPARTMENT

a. Functions and Responsibilities

Prior to the last war the Mines Department concerned itself almost solely with the administration of the Mines Act, its principal interest being the safety and working conditions of mine labor. Administered by a Chief Inspector of Mines and subordinate Inspectors, the Act provided also for mining boards and mining committees which could exercise many of the functions of inspectors and act much as civil courts with respect to mining. In this latter respect, the Department's principal function was that of guarding the interest of the State by exercising control and regulation of the mineral industry. Probably it was derived from the regalian conception that the mineral resources of a country belonged to the crown, as somewhat distinct from the democratic principle that a country and its resources belong to its people or citizens.

Mineral deposits are irreplaceable and, when undergoing exploitation, are wasting assets. Inefficient or wasteful methods of development and exploitation render impossible the maximum recovery of useful minerals and result in an irrecoverable loss of the country's natural wealth. It is believed therefore, that in addition to the function which it has hitherto exercised, the Mines Department should provide technical advice for small and medium sized mining operations in order to secure the adoption of efficient mining and metallurgical methods. With the same objective in view, the Department's technical advice and recommendations should govern generally the Government's administration and enforcement of mineral industry legislation and taxation.

To this end the staff on the Mines Department should include several qualified mining engineers willing and able frequently to tour the mining districts, visit operations and advise operators on methods of ore development, extraction and beneficiation. They should emphasize to the operators their function of providing unbiased instruction and technical assistance and minimize their concern with administration and regulation. An auxilliary function of these engineers would be the preliminary appraisal of mineral deposits discovered in the course of the field work of the Geological Department.

In the immediately preceding section, basic changes in existing mineral industry legislation and taxation were recommended. If these recommendations are approved and implemented by Government, the Mines Department would be wholly responsible for the issue of mineral exploration licenses and responsible for prior approval of the issue of mineral exploitation licenses, final approval in the latter instance resting with the Minister of Mines. For this purpose the Mines Department would have to include a license section or bureau. The head of this office would be responsible to the Director for the processing of all license applications. Prior to the submission of an application to the Director for approval or denial, the license office would effect any necessary investigation of the applicant or the area under application, using the services of the Department's technical staff for this purpose as required.

In addition to the foregoing functions and responsibilities, the Mines Department should have a statistical section responsible for the current compilation and recording of all mineral production and export data. Through the Department this data should be made available to all other interested government offices and to private individuals, and care should be taken by Government to eliminate any duplication of this responsibility in other departments or agencies.

b. Administration

The development of an effective Mines Department will inevitably progress slowly if dependence is placed solely on the present availability in Burma of qualified technical personnel. Considering the requirements of the Mines Department, the Geological Department, and the Mineral Resources Development Corporation alone, as distinct from mineral industry needs, it will be some years hence, before there are available enough professionally trained Burmese geologists, mining engineers and metallurgists to carry on the full program. In determining the technical personnel requirements of these establishments, every care should therefore be taken to insure that there is not duplication of efforts, functions and responsibilities.

With these important considerations in mind an initial organization such as that outlined below is recommended. In the future, staff can be added as the need develops.

MINISTRY OF MINES
THE MINES DEPARTMENT
Director

Mines Inspection Section	*Technical Assistance Section*	*License Section*	*Statistical Section*
1 Chief Inspector	1 Chief Mining Engineer	1 Chief Licensing Officer	1 Mining Engineer Analyst
2 Assistant Mines Inspectors*	1 Assistant Mining Engineer		

* One would normally be assigned to north and central Burma and the Shan and Kayah States and the other to the Tenasserim Division.

4. THE GEOLOGICAL DEPARTMENT

a. Functions and Responsibilities

For most countries, and especially for a country such as Burma which has mineral resources of proved economic worth, a strong and efficiently conducted geological survey or department is a wise investment. Until the separation of Burma from India in 1937, the Geological Survey of India maintained a party in Burma with permanent headquarters in Rangoon. For several reasons, including the financial crisis of 1931, the party never attained its planned strength of about 20 technical officers, but, at the time of separation, consisted of a superintending geologist, a geologist who served as technical adviser to the Warden, Burma Oilfields, an assistant geologist and a chemical assistant. When Burma separated from India the party was redesignated the "Burma Geological Department," the Government of India agreeing to lend to the Government of Burma for a period of five years the geological officers necessary to maintain the Department at its immediate pre-separation strength of four men. This organization continued to function until the invasion of Burma early in 1942.

At Simla, in June 1944, it was decided that the Burma Geological Department should comprise one superintending geologist, six geologists and twelve assistant geologists. The Consultative Committee further recommended that the Government of India lend geologists to staff the department until the Government of Burma could recruit and train Burmese nationals to replace them.

For various reasons this temporary staffing by the Geological Survey of India never materialized, although a Mr. E. J. Bradshaw of that Survey was released on request of the Government of Burma to accept appointment as Director, Burma Geological Department. This post he held until shortly after the inauguration of the Union of Burma in 1948. Since then the Department has functioned under an acting Director, Dr. Ba Thi (Ph.D., Industrial Chemistry), assisted in recent years by two state scholars, Dr. Kyaw Myint (Ph.D., Geology), U Min Din (M.Sc., Geology), a chemical assistant, and a small staff of clerks and office personnel.

In considering the reconstitution and expansion of the Geological Department, there are two principal questions on which there has been a wide division of opinion and which must be resolved by the Government in determining its course of action. First, confronted with financing the rehabilitation and expansion of the Burmese economy, what place should the needs of this Department hold in overall planning? Second, what is to be the policy of recruiting technological personnel to conduct the expanded functions of the Department?

The fact that in the years immediately preceding the war, mineral exports accounted for approximately 33% of the national total, should receive serious consideration in determining what percentage should be allocated to the mineral industries from the funds budgeted for overall industrial rehabilitation and expansion. It is assumed that most of the funds allocated would be distributed between: (1) the development of production from the Kalewa coalfield; (2) the rehabilitation and expansion of the oil industry; (3) the fulfilling of the Government's commitment in its participation with the Burma Corporation (1951) Ltd.; (4) implementation of the Myingyan zinc project and the necessarily contingent development of production from the Lough Keng zinc ore deposit; (5) financing the activities of the Mineral Resources Development Corporation, through which presumably the Government would secure implementation of most or all of the preceding items; and (6) the reconstitution and expansion of the Geological Department and the Mines Department.

The first five of these undertakings might well absorb most of funds prudently allocable from a reasonably balanced national budget, and it is certain that they would more than exhaust the resources of national technological personnel. Despite the recognized basic importance of a Geological Department in the development of the country's mineral resources, unless funds can be made available to advance the execution of the whole mineral development policy of the Government along parallel lines and simultaneously, it would seem wise to secure first the rehabilitation of prewar production operations, expansion of their former rate of production where economically feasible, and the development of the most promising production potentialities presently recognized, namely, the Kalewa coalfield, the Myingyan zinc project and the Lough Keng ore deposit.

Under subsequent headings, the functions and responsibilities of the Mineral Resources Development Corporation and the projected survey of mineral resources are discussed. The Mineral Resources Survey, as presently envisaged, would be conducted as a principal activity of the exploration division of the Corporation. The initiation and conduct of a continuing program for educating and training national technological personnel would be a chief concern of the Corporation's training division. The technological services and personnel which the Corporation would need to employ for its mineral exploration and development work would, initially, have to be obtained very largely from sources outside Burma. All of the activities of the Corporation could and should be correlated very closely with the policies and objectives of the Geological Department and all other government departments and agencies concerned with the discovery and development of mineral resources. Hence, much if not all of the exploration work accomplished would contribute specifically to the Geological Department's ultimate objectives. As suitably trained Burmese technical personnel became available through execution of the Corporation's training program, they could be absorbed by the Department until its eventual reconstitution at not less than the strength recommended by the Simla Committee was effected.

Presumably, adequate funds will be made available more readily for the Corporation's activities and objectives than for those of the Geological Department. Therefore, it is recommended that until trained national personnel begin to become available from the Corporation's training divisions, recruitment for the staff of the Geological Department be subordinated to the requirements of the other agencies.

G.U.B. MINERAL RESOURCES DEVELOPMENT CORPORATION.

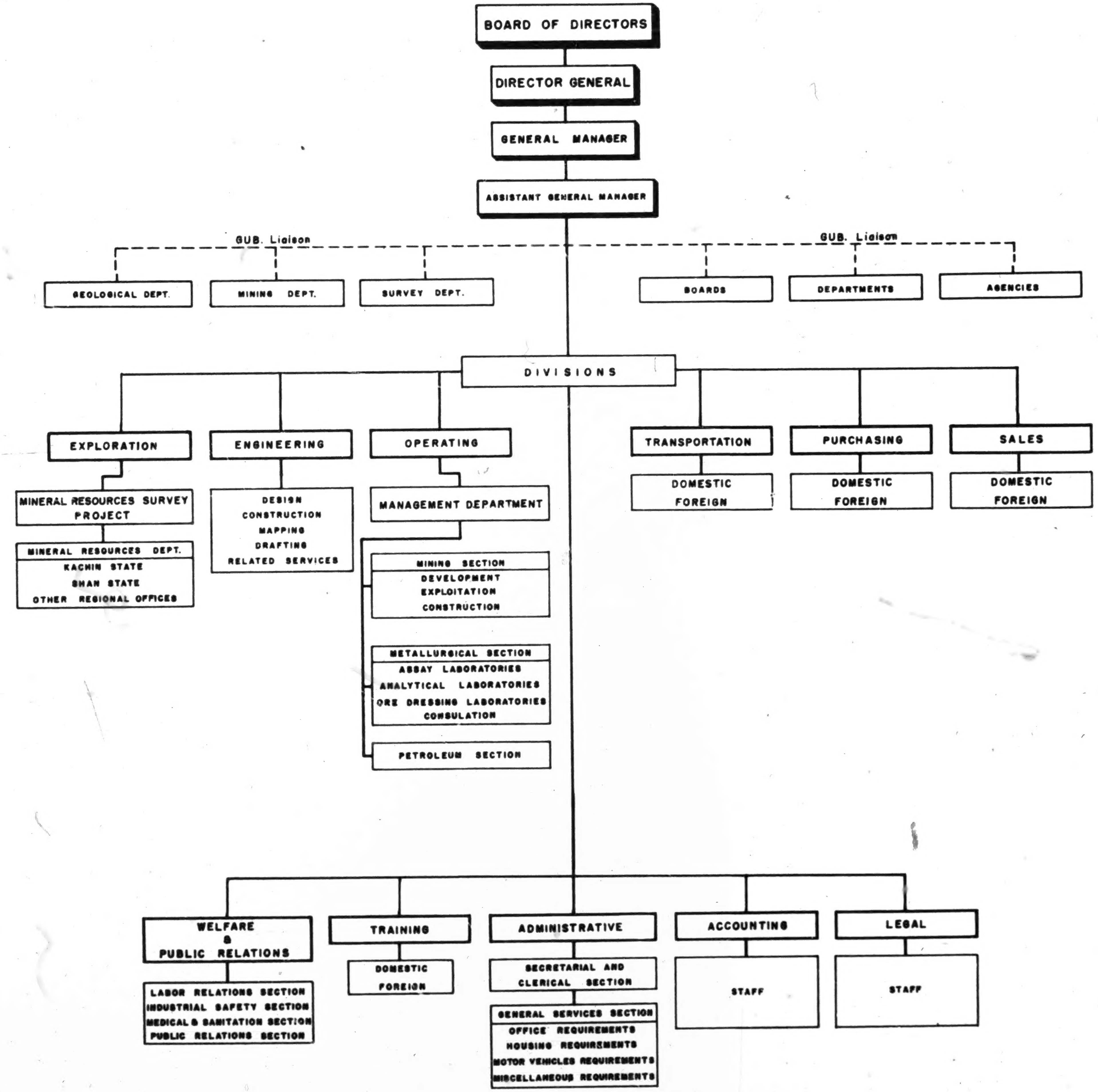

BOARD OF DIRECTORS
DIRECTOR GENERAL
GENERAL MANAGER
ASSISTANT GENERAL MANAGER
GUB. Liaison
GEOLOGICAL DEPT.
MINING DEPT.
SURVEY DEPT.
GUB. Liaison
BOARDS
DEPARTMENTS
AGENCIES
DIVISIONS
EXPLORATION
MINERAL RESOURCES SURVEY PROJECT
MINERAL RESOURCES DEPT.
KACHIN STATE
SHAN STATE
OTHER REGIONAL OFFICES
ENGINEERING
DESIGN
CONSTRUCTION
MAPPING
DRAFTING
RELATED SERVICES
OPERATING
MANAGEMENT DEPARTMENT
MINING SECTION
DEVELOPMENT
EXPLOITATION
CONSTRUCTION
METALLURGICAL SECTION
ASSAY LABORATORIES
ANALYTICAL LABORATORIES
ORE DRESSING LABORATORIES
CONSULATION
PETROLEUM SECTION
TRANSPORTATION
DOMESTIC
FOREIGN
PURCHASING
DOMESTIC
FOREIGN
SALES
DOMESTIC
FOREIGN
WELFARE & PUBLIC RELATIONS
LABOR RELATIONS SECTION
INDUSTRIAL SAFETY SECTION
MEDICAL & SANITATION SECTION
PUBLIC RELATIONS SECTION
TRAINING
DOMESTIC
FOREIGN
ADMINISTRATIVE
SECRETARIAL AND CLERICAL SECTION
GENERAL SERVICES SECTION
OFFICE REQUIREMENTS
HOUSING REQUIREMENTS
MOTOR VEHICLES REQUIREMENTS
MISCELLANEOUS REQUIREMENTS
ACCOUNTING
STAFF
LEGAL
STAFF

PLATE NO. I-A

However, a director qualified in the field of geology should be appointed to coordinate the work of the present staff, to formulate specific plans for expansion and to coordinate the Department's present activities with those of the other government agencies and departments, particularly the Corporation and the Mines Department.

5. THE MINERAL RESOURCES DEVELOPMENT CORPORATION

The establishment of a "Union of Burma Mineral Development Corporation" was one of the important recommendations in the Preliminary Report. Outlined in that Report were the activities, functions, responsibilities, government departmental and private industrial interrelationships, and the authority that such a Corporation should have. Subsequently, legislation was enacted establishing the Minerals Resources Development Corporation as a government entity as from November 1, 1952.

The enabling legislation gives the Corporation wide powers which encompass most, if not all, of the recommendations in the Report. One exception is that the Directorate is staffed only by Government officials. This means that there is no representation on the Board of Directors from private banking, commerce, or persons active in private mining enterprise.

Although recruitment of Corporation personnel and staff began following its establishment as a legal entity on November 1, 1952, progress in this and other respects has been slower than expected. This may be attributable in part to the fact that the Corporation has not, as recommended, been relatively "autonomous," or operated "in every respect . . . as a private enterprise . . . " It had been recommended also that the executive head of the Corporation should possess "some technical knowledge and wide business experience" and "should be given the widest possible latitude for carrying out the directives of the Board." Furthermore, it was emphasized that initially, and for some time thereafter, until qualified Burmese replacements could be made available, the Corporation would need to employ a few foreign mining engineers and geologists, and managerial and technical consultant services.

Although, following establishment of the Corporation in November 1952 an organization chart (substantially as shown on Plate 1A) was submitted to the Director-General, the Corporation still has no effective staff or organization, and no executive head who can presently give it undivided or adequate attention. The Director-General of the Board, who presently acts in this capacity, has numerous other governmental duties and responsibilities, and moreover appears to have been delegated too little authority and latitude of action. So far the Corporation has employed personnel to fill the following positions only: one liaison officer, one clerk-accountant, one lower division clerk, one stenographer-secretary, one typist and two peons. No suitable provision has yet been made for officers for the Corporation or for the housing of its related facilities and services such as centralized laboratories which are needed to serve the assay, ore-dressing and metallurgical testing requirements of the Corporation as well as the petrographic, mineralogical and analytical needs of the Mines Department and the Geological Department.

If the Corporation is to function effectively at any reasonably early date as the principal government entity responsible to the people of Burma for securing the development and exploitation of their mineral resources, considerably more energetic and aggressive action must be taken by the Board in organizing and staffing it for this purpose. There is no need to modify substantially any of the principal recommendations submitted in the Preliminary Report. On the contrary, the expeditious implementation of those recommendations on which no effective action has yet been taken is urged, particularly with respect to the need for engaging effective full-time management at the earliest date.

It is strongly recommended that the Board of Directors should determine policies and that the Director-General should be responsible to the Board for seeing that they are carried out. For the execution of these policies, reliance should be placed on a properly qualified and competent general manager possessing a satisfactory record of business and mineral industry experience, responsible directly to the Board through the Director-General. Concurrently, the Corporation should arrange for the employment of the foreign technical staff and consultant services initially required. The managerial and technical services needed can best be obtained by employing the services of a reputable and competent firm of mining engineers and consultants. Failing this, the general manager employed independently should be given wide latitude in choosing his own technical and administrative staff.

In addition to the functions, activities and responsibilities implied in the Preliminary Report, there are several additional responsibilities which the Corporation should undertake.

First, the mineral resources survey project, previously recommended as a separate project for reasons of expediency but not yet initiated, should at once be undertaken by the Exploration Division of the Corporation as a continuing program, but on a considerably reduced scale.

This program should be conducted with a view to expanding its scope as fast as improvements in security conditions permit. Execution of the program should be correlated at all times with the functions and activities of the regional mineral development departments of the Corporation, which it will be noted from the organization chart are also a responsibility of the Exploration Division, and with the Mines Department and the Geological Department.

So far as the execution of specific projects is concerned, the Corporation staffing requirements in connection with securing the execution of the Kalewa coalfield development, the Myingyan zinc project, and the development of the Lough Keng ore deposit can be much more clearly defined. In determining the minimum technical staff needed by the Corporation for all of its operations, the requirements for these specific projects and those of the Exploration Division should be carefully assessed and correlated.

6. MINERAL RESOURCES SURVEY

The Mineral Resources Survey has already been mentioned briefly in discussing the functions and responsibilities of the Mineral Resources Development Corporation. The plan for the survey was drafted as a GUB project proposal in April 1952, following the submission of the Preliminary Report and at a time when it appeared that the establishment of a mineral development corporation might be considerably delayed. It was thought that pending the possibly later establishment of the Corporation, needed technical assistance might thus be made available for Burma more quickly. In implementing the project close coordination and collaboration with the Geological Department was envisaged, although it was realized that at a later date such exploration might be conducted to better advantage by the Corporation, if and when it should be established.

Essentially the objective of the project, which provided for a long-term continuing program of mineral exploration, was to increase Burma's mineral resources by the discovery of presently unknown deposits and of extensions of known deposits. Considering the recognized underexplored and underdeveloped status of the country's mineral resources, it was considered to be the one measure which, much more than any other, could make the greatest long term contribution to the social and economic welfare of Burma.

The methods of prospecting which in the past have resulted in discoveries of ore bodies have not entailed the use of elaborate equipment. Generally, ore has been discovered when it has been apparent from rock outcrops. But in Burma, as in many tropical to subtropical countries, mineral exploration and prospecting is handicapped by physical conditions which render the routine methods of the past backward, time-consuming and insufficiently productive except where comparatively small areas are to be explored. With topography which renders access in many instances very difficult, forest and dense jungle-covered terrain, thick overburden, and other physical conditions which cover outcrops and ore indications, many areas which might contain valuable ore deposits have never even been reconnoitred.

The project provided for a well planned and executed program of mineral exploration and prospecting, employing geologists, geophysicists, mining engineers, aerial photography, the use of an airborne magnetometer and other geophysical equipment. It provided also, with the objective of eventually staffing the continuing program completely with nationals, both short-term and long-term domestic and foreign training programs for Burmese technical personnel. As proposed, execution of this program over the first five years called for an estimated expenditure of $3,861,000 and K1,23,00,000.

In drafting the program, it was necessarily assumed that security conditions would permit its execution on the scale contemplated, and there was good reason for believing that much of the foreign technical assistance and equipment required would be provided through TCA. More recently, up to the termination of TCA in Burma, it was still contemplated that assistance from this source would be available, although on a necessarily reduced scale due to the limitations imposed on the originally contemplated scope of activities by current security conditions.

In spite of present conditions the mineral resources survey should be initiated and conducted as a continuing program by the Mineral Resources Development Corporation through its Exploration Division and Training Division, and it is recommended that appropriate provision for securing the necessary technical personnel be made by the Corporation at the earliest date with a view to expanding the scope of activities as fast as improvements in security conditions warrant.

7. REGIONAL MINERAL DEVELOPMENT

In advancing the area development projects, as recommended in the Preliminary Report, continuing investigations were made in the three principal regions of Burma which include practically all the sources of economic mineral production to date, excepting petroleum. These three broad regions are: the Shan

States, and contingent areas including the Kayah, Keng Tung and Wah States; the Kachin State, including the Naga Hills tract, north Burma and the Upper Chindwin River country; and the Tenasserim Division. The investigations in the first two regions were conducted largely by resident mining engineers stationed at Taunggyi (Shan State) and Myitkyina (Kachin State). Security conditions in the Tenasserim Division, however, remained such that only two field investigations were made.

In the Kachin State, at the request of Government, the Consultants undertook general direction of the activities of the former Office of Mines and Industries of the Kachin State as from October 1, 1952, the date of its transfer from the Kachin State to the Ministry of National Planning and Religious Affairs. Thereafter, the office was redesignated the Mineral Resources Department of the Kachin State, subsequently effective February 1st, 1953, all responsibilities for the Department were transferred from the Ministry to the Mineral Resources Development Corporation.

Near the end of the current field season, under date of May 11, it was recommended to the Corporation that the Department be re-established as a regional office of the Corporation, its principal functions and responsibilities to be those of securing the exploration and prospecting of mineral occurrences in the Kachin State and adjacent areas. It would not develop mineral deposits for production.

In effecting the establishment of the Mineral Resources Department of the Kachin State as a regional office of the Corporation, it was recommended that all staff and employees of the former establishment be released as soon as possible under existing government procedure, and that the regional office then engage a minimum administrative staff until such time as a regional director could be appointed and placed in charge. Thereafter, the director would proceed with building up the organization as feasible and desirable.

The activities of the regional offices would fall under the Exploration Division of the Corporation, and their broad direction would be the responsibility of the Chief of this Division. Responsible to the Chief of the Exploration Division for the local direction and operation of the regional offices would be the regional directors, resident at Myitkyina and at Taunggyi respectively, in the cases of the Kachin State and Shan State regions, and probably at Tavoy, in the case of the Tenasserim Division region. It was recommended that the regional directors be persons well qualified by technical training in mining geology, and that they should possess a suitable background of field and operating experience.

Each regional office would operate with a permanent staff which would be augmented on a temporary basis during each field season. During the monsoon season, certain of the permanent employees would receive practical training at centres to be established at Bawdwin and, as soon as practicable, at Mawchi mines.

Generally, the regional offices of the Corporation would be responsible only for reconnaissance, exploration and prospecting work designed essentially to discover mineral deposits of economic value, the further development of which, initially or to the production stage when justifiable, the Corporation would proceed to secure through its Exploration Division and other appropriate departments.

The Mineral Resources Survey which has been recommended as a principal activity and responsibility of the Exploration Division of the Corporation would, of course, be coordinated with the activities of the regional offices in a manner which would prevent duplication of effort. The results of the survey and of the work of the Exploration Division generally would determine what other regional offices might be established advantageously.

The exploration objectives in the three principal regions referred to have been indicated generally in the preceding section. Briefly, the most important initial objectives in these regions may be summarized as follows:

a. Kachin State

In the Kachin State a search should be made in the Putao area for economic deposits of lead-silver ores, taking advantage of the guidance afforded by the old slag dumps of early Chinese miners, and the indications resulting from geological reconnaissance of the area. The second most important area for early reconnaissance, and detailed examination where indicated, lies in the Hukong Valley area.

b. Shan State

In the Shan State region, the antimony deposits at Mong Sang should be carefully prospected and explored; underground exploratory workings should be driven at Lough Keng in accordance with the recommendations already submitted; efforts should be made to discover other economic deposits of manganese ore similar to that being mined at Ho Pong; and investigations should be initiated to determine whether there is any possibility of working the lead carbonate area at Mawson on a large scale by surface mining methods. Further exploration of phosphate rock should be made in the area southwest of Loikaw.

c. Tenasserim Division

In the Tenasserim Division, once security conditions permit the resumption of normal mining operations, thorough examination and exploration of many vein deposits should indicate possibilities which owners and operators would be well advised to explore. Reconnaissance in the Dawna Range would probably disclose deposits of tin and tungsten minerals which so far have not been exploited.

8. THE DEVELOPMENT OF THE PETROLEUM INDUSTRY

For a comprehensive discussion of the petroleum industry and its development potentialities, reference should be made to the "Report on the Economics of the Petroleum Industry in the Union of Burma" prepared by Mr. Stuart St. Clair and submitted to the Government in March 1953. In briefer form, the observations, conclusions and recommendations are discussed and summarized in the following paragraphs.

(a) Chauk is the only field in Burma now in production. The 1952 output was 645,000 Burma barrels of 40 Imperial gallons. Present daily production is less than the capacity of the wells already drilled, output being limited by refining and river transportation facilities. A new distillation plant with a capacity of 2,700 barrels per day will shortly be in operation, but only the refined products from this throughput can be shipped. Therefore the present topping plant must be shut down until additional tugs and barges can be delivered which may not be until early 1955. Chauk has possibilities of production from deeper sands, but it is uneconomic to prove them at this time since there is no outlet for its present potential. What is said of Chauk includes Lanywa, its sister field.

(b) Yenangyaung, the second largest producing field before the war, is in insurgent hands and has no regular production. The possibilities of extensions to the north, south and west as well as possible production from deeper sands are good.

(c) The estimated proved reserves for Chauk, Yenangyaung and the other known fields are 93,000,000 barrels. There is valid reason to believe that this estimate can be increased when security conditions prevail and a definite exploration program can be started. A number of areas of geologic prominence should be drilled and an equal number warrant further study. Drilling now being done near the boundary between Burma and East Bengal may throw some light on geologic possibilities in the Arakan coastal area.

When security prevails, a complete or partial exploration program can be undertaken as conditions warrant. The areas included in the full program presented in the Report under reference are listed below, together with estimated exploration costs.

Exploration Areas	*Estimated Costs*
	K
Chauk	2,55,00,000
Yenangyaung	1,13,00,000
Ondwe	26,00,000
Ngashandaung	16,00,000
Palanyon	17,00,000
Mindegyi	22,00,000
Yinaing	20,00,000
Lema	20,00,000
Yedwet	25,00,000
Yenangyat	24,00,000
Ainggyi	24,00,000
Delta Area	70,00,000
Geophysical Survey	30,00,000
Geological Surveys	18,00,000
Total	4,50,00,000

(d) If the exploration program proposed develops a large reserve of petroleum in the Delta area, production costs should be relatively low, and the refined products could enter a competitive export market. Plans to rebuild the refinery at Syriam should then be made, the capacity depending upon the amount of crude oil reasonably assured.

(e) If the exploration in the upper fields is also successful, and if it is decided to move some of the crude oil to the Syriam refinery, barges and tow boats for oil transportation must be provided. The size of the Syriam refinery would depend upon whether all refining were to be done there or whether the Chauk refinery would be maintained to furnish refined products to upper Burma. The Syriam refinery may cost around K7,50,00,000 to K9,00,00,000 and the pipeline K3,00,00,000 or more.

(f) The cost of river transport of crude petroleum from the upper fields to the Rangoon area is presently prohibitive. The actual cost from Chauk area would be about K11.00 per ton under normal security conditions with a capital investment ranging from about K1,10,00,000 to K1,50,00,000 for respective quantities of from 7,500 to 10,000 barrels per day.

If the Delta drilling is unsuccessful in opening large pools, Burma's petroleum industry is dependent upon the present estimated reserves in the upper Burma fields and the probable increase in those reserves as a result of future exploratory drilling.

In such a case, Burma would be in the following position in meeting its petroleum needs: by 1959, the domestic requirements of petroleum products will be about 98,000,000 gallons. To meet the demand for specific products such as petrol, kerosene, diesel oils and fuel oil, a crude production of 8,000 barrels per day will be required. On this basis the known reserves in the present fields will be depleted in some 25 years with another ten-year period of diminishing yearly production. New pools and added reserves will increase the life of the upper fields commensurately with the success of the drilling program.

To meet the 1959 demand, additional refining capacity will be necessary. The Chauk refinery of 2,500 barrels daily output will provide the needs, in part, of upper Burma. Additional refining facilities will be required for 5,500 barrels per day. Modern equipment will be needed to produce diversified products and the rebuilding of a small unit at Syriam would be in order. The cost may be around K5,00,00,000 to K6,00,00,000, subject to changing prices of equipment and labor.

(g) The Delta area occupies a key position in the future petroleum economy of the country. If a large production should be developed, the reconstruction of the refinery at Syriam is assured and Burma's economy is strengthened because of a profitable export trade. If efforts to find oil pools in the Delta area are unsuccessful or the cost for the amount produced is prohibitive, the reserves in the upper fields are the backbone of the future oil industry in Burma.

(h) It is believed that it is economically sound for the Government to participate in the joint oil venture as it will thereby gain for itself a participation in the revenue derived from the exploitation of one of its own natural resources, and also retain a partnership with the Associated Oil Companies, an organization with wide experience in the management and administration of the business. Under joint ownership, the exploration and development program proposed in the Report can be put into effect as soon as insurgency is quelled and security prevails in the several areas recommended, and when funds are provided. It is recommended that administration of the Goverment's interest in the joint oil venture be vested in the Mineral Resources Development Corporation.

(i) For the good of its own petroleum economy, the Burma Government should not hesitate longer in renewing prospecting licenses, mining leases and the extension of geophysical prospecting guarantees. The conservation of the petroleum resources of the nation are of primary interest to the Government. The applicant for prospecting licenses and mining leases should be screened as to competency, technical and financial, to develop a valuable national resource.

In the Report referred to, it was recommended that for the encouragement of the development of all natural resources the Government should give consideration to the following incentives:

(1) Remission of import duties on equipment and supplies used exclusively in the exploration for and development of a natural resource.

(2) Provision for a generous depletion allowance on mineral production.

(3) Provision for the early return of venture capital.

(j) Unless present estimated reserves in Burma are materially increased, the petroleum resources should be conserved for the use of the nation. In this event there should be a modified development program, one which should be expanded with the development of the economy of the country. Transportation and refining capacities should also be cut to fit the crude producing pattern.

9. SPECIFIC MINERAL DEVELOPMENT PROJECTS

a. The Kalewa Coal Project

(1) Summary

The objective of the Kalewa coal project is to provide the solid fuel requirements of Burma indigenously. To date there has been no production of solid fuel in Burma; all of the country's requirements having been imported, principally from India. The Kalewa coal seams are the only ones in Burma known to show sufficient extent and quality to meet the country's requirements.

A report has been prepared and submitted to the Government entitled "Kalewa Coalfield Development and Transport of Kalewa Coal." The report sets forth objectives, reviews field and laboratory investigations to date, describes the project and its implementation, presents estimated capital and production costs, economic justification and conclusions and recommendations. Reference is invited to this report for the many details not included in the following summarized presentation.

In brief, it is proposed to establish at Kalewa a mining operation capable of producing 750,000 tons of run-of-mine coal per 300-day year. Approximately four years would be required for continued exploration, mine development and the construction and installation of surface plant and equipment at an estimated cost of $10,626,917 plus K2,21,34,200. A working force of about 1,400 would be employed and coal products totalling 417,000 tons annually would be prepared for distribution to various markets. Compared to the cost of importing coal under the optimum price conditions expected in the future, the use of this indigenous production would secure foreign exchange benefits of approximately

K2,22,00,000. The additional capital cost of providing river transport facilities for moving Kalewa products to market is estimated at K5,14,36,495.

Subsequent to the submission of the Kalewa project report in late June, additional weathering tests were run, in Rangoon monsoon weather conditions, on briquette No. 27. This briquette has proved satisfactory and compared favorably with commercial American briquettes when tested in United States laboratories. The severe conditions of exposure to the monsoon rains caused deterioration of the briquette to the extent that it is doubtful whether the briquette is suitable for outdoor storage and transport in Burma. The use of Kalewa coal as a locomotive fuel must remain contingent upon either improving the weathering qualities of the briquettes, under further research work being done under GUB Project No. 61, or the transportation and storage of briquettes under cover. Final implementation of the project must await results of diamond drilling and the research work on the beneficiation of the coal now under way.

It is presumed that the Mineral Resources Development Corporation will secure execution of the project, and it is recommended that it also be made responsible for the establishment and operation of all river transport facilities required for the distribution of the coal to market points. In so doing, it is strongly recommended that the Corporation engage the services of a well qualified firm which provides mining consultant, engineering and management services for implementation of the development program during the initial stages, and to direct and manage operations until suitably trained indigenous technical and supervisory personnel become available.

(2) Objective

Stated more fully than in the summary, the project objective is to provide all the solid fuel requirements of Burma indigenously in order to secure for the country the many and diverse economic benefits which would result therefrom. These benefits are listed hereinafter in paragraph (6), economic justification.

The objective includes the underground development and equipment of a mine capable of producing 750,000 tons of run-of-mine coal per year, and the construction of all surface plant and facilities necessary for servicing underground operations and for preparing the coal for market. As the mining operation will be developed in sparsely populated virgin country, housing for a working force of 1,500 and all the necessary community facilities and services related thereto must be provided.

The estimated solid fuel requirements of Burma are shown in Table XXI-1.

TABLE XXI - 1

ESTIMATED SOLID FUEL REQUIREMENTS OF BURMA

Consumer Requirements	*Tonnage*	*Tonnage Purchased*	*Estimated Tonnage Requirements*	
	Prewar	*1951–52*	*1957*	*1960*
Present Users				
Rangoon Electric*	50,000	29,142	94,000	38,000
Burma Railways†	180,000	86,812	150,000	150,000
Inland Water Transport‡	100,000	13.616	40,000	20,000
Present Industries	30,000	17,069	15,000	15,000
Rangoon Corporation	—	7,763	8,000	8,000
Port Commissioners	—	7,752	5,000	5,000
Private Boat Owners	—	1,469	5,000	5,000
Miscellaneous	—	5,337	—	—
Total, Present Users	360,000	168,960	317,000	241,000
Projected Users				
Kalewa Mine Plant§	—	—	20,000	28,000
Myingyan Power Plant ‖	—	—	35,000	50,000
Antimony Project	—	—	—	18,000
Akyab Industries	—	—	87,200	90,000
Myingyan Industries	—	—	73,350	75,000
Rangoon Industries	—	—	122,250	135,000
Metallurgical Plants	—	—	31,000	33,000
Total, Projected Users	—	—	368,800	429,000
Grand Total	360,000	168,960	685,800	670,000

* Present expansion rate 30% per year will be relieved by Pegu hydroelectric in 1958.

† Present usage of wood to be supplanted; dieselization contemplated for main line and also certain shunting service.

‡ Contemplates continuance of dieselization program.

§ Kalewa mine and community.

‖ Supplementing Paunglaung hydroelectric in 1960.

(3) Field and Laboratory Investigations

Based on the early field examinations and analyses of coal samples and a review of all the information available at that time, it was recommended in the Preliminary Report that certain additional field and laboratory investigations be made. If the results therefrom proved favorable, earliest development of the coalfield for production was recommended. Surface exploration had indicated satisfactory continuity of the coal measures along the dip to more than 1,000 ft. below the surface. The latter, however, and the other physical characteristics of the coal at depth could only be proved by diamond drilling.

The continuing investigations pursued were outlined briefly in Section D of this chapter. The action taken in this respect and the results to date of both field and laboratory investigations are now reviewed in greater detail. They are described still more fully in the project report.

In order to provide for the principal field and laboratory investigations recommended, GUB Project Proposal No. 61 for "Kalewa Coal Development, Preliminary Field and Laboratory Investigations" was drafted and approved. In accordance with the proposal, $216,500 plus K6,35,000 were obligated by TCA and GUB and in February 1953, execution of the project was assigned to Pierce Management, Inc. of Scranton, Pennsylvania.

Meanwhile, the investigations already initiated were continued as vigorously as possible. The results to date of all investigational work are reviewed in succeeding paragraphs.

(a) **Field investigations.** Sinking operations in the inclined prospect shaft at Thitchauk Camp were continued by the GUB Mining Adviser and coal samples of several tons taken from near the bottom of the shaft were dispatched to the United States, Germany and Japan. The proposed lines of diamond drill holes were located and partly surveyed. A ground survey party is continuing this work and in addition is making detailed topographical surveys of the proposed surface plant and community housing sites in the vicinity of Thitchauk Camp, the mine opening locations, the barge loading station along the Myittha River and, importantly, it is surveying the ground control points required for some 40,000 ft. north of the river for aerial photogrammetric mapping of the whole area.

Aerial photographs were obtained of the coalfield area extending from 12 miles to the north of the Myittha River to three miles to the south and also for a five mile strip running east along the Myittha River to include its confluence with the Chindwin River. The photographs were taken in March 1953, after earlier attempts in October and November 1952 proved unsuccessful due to atmospheric conditions. Completion of the ground control survey and topographic mapping dependent thereon will greatly facilitate the correlation of geological indications confirming the lineal extent and continuity of coal seam occurrences observed during ground exploration work.

Additional ground exploration of the area was accomplished by a reconnaissance party which crossed from the Chindwin River to the Waya Chaung Valley some ten miles north of the Myittha River. Numerous coal outcroppings were discovered in the beds of four streams traversing the general strike of the coal measures considerably north of the previous limit of field exploration.

The field investigations contemplated under Project 61 are under way. Essentially, the program provides for approximately 17,000 ft. of diamond drill exploration to determine the continuity of the coal seams in workable circumstances to a vertical depth of 1,000 ft.

(b) **Laboratory investigations.** Laboratory investigations to determine the best methods of utilizing Kalewa coal have been conducted in the United States by Mr. C. E. Lesher of Pittsburg, Pennsylvania, on bulk samples obtained from the prospecting shaft. In Germany similar investigations by Kloechner-Humboldt-Deutz have been in progress.

(1) The conclusions reached from the investigations in the United States are as follows:

(*a*) Friability is a predominant physical characteristic of Kalewa coal. It breaks into pieces on handling or after weathering, the latter becoming apparent as a result of a 12-week exposure test made in Rangoon. This characteristic precludes its satisfactory use as hand-fired fuel for most industrial purposes.

(*b*) The coal is an ideal fuel for combustion on a spreader stoker or for burning in suspension in pulverized form. Its ease of ignition, ready release of volatile content, low ash, and combustion without smoke are important characteristics. With proper equipment it can be unqualifiedly recommended for stationary boiler firing. A combustion test was conducted at Battelle Memorial Institute, Columbus, Ohio, in a Kewanee boiler rated at about 10,000 pounds of steam per hour using an Iron Fireman pneumatic spreader stoker which demonstrated, within the limit of coal sample available, that it can be successfully fired by a pneumatic spreader stoker.

(c) Kalewa coal must be briquetted for utilization by hand firing. Briquettes were prepared from Kalewa coal with 7% asphalt binder which would have to be imported into Burma. These briquettes softened and crumbled on the firebed during a combustion test of a 200-pound sample on a Burma Railway locomotive in March 1953 whereas briquettes prepared from Kalewa char with 8% of asphalt binder exhibited a superior hot strength when an equal weight of sample was similarly tested. Both briquettes displayed equivalent heating qualities, maintaining steam pressure comparable to that produced by using Indian coal.

The char, obtained by distillation of Kalewa coal at 950° F., has a volatile content of about 20% compared with the 40% volatile content of the raw coal. In the distillation process the coal yields about 8·6% by weight of tar, 48% of which is briquette pitch. As this is less than the quantity of binder required for briquetting, the shortage would have to be made up with imported petroleum asphalt.

A subsequent char briquette of adjusted granulometric composition and with 8½% pitch binder has shown adequate strength and is being further investigated for resistance to weathering, either treatment or sheltering against rainy season ravages appearing indicated. Weathering tests in Rangoon reflect a 12% degradation of this briquette after two weeks exposure.

The preparation of several tons of char briquettes for return to Burma for full scale locomotive test is contemplated in the continuing execution of Project No. 61.

(*d*) Metallurgical char with less than 10% volatile matter can be made by calcining the 20% volatile content char described in (*c*). It will have low ash, low sulphur and a high fixed carbon content. In every way it will be a desirable carbon for zinc ore reduction, making possible the establishment of a zinc refining industry in Burma.

(*e*) Metallurgical briquettes suitable for replacing imported coke in Burma Corporation's lead furnaces at Namtu have been prepared by adding 10% of bituminous coking coal to the 20% volatile char made from Kalewa coal, briquetting this mixture with a pitch binder and recarbonizing the briquettes at a temperature of 1,500° F. The products were hard, grey briquettes of sufficient strength for use in the lead blast furnaces under reference and other low-head types of furnaces.

(*f*) Estimates of capital and operating costs have been made for the beneficiation facilities required to prepare these various products for market.

(*g*) The heating value of the several types of briquettes greatly exceed the heating value of the Kalewa coal from which they were derived. Also the several types of briquettes showed stability in transport as well as resistance to weathering, with less than 2% deterioration after six weeks of exposure followed by five minutes of vigorous screening in Rangoon dry season weather. After the Kalewa project report was completed and submitted, in order to additionally check the stability of the Kalewa char briquettes, additional weathering tests were conducted during six weeks, ending July 30, 1953. These tests were not satisfactory and indicated excessive briquette disintegration during monsoon weather. Additional research must be carried out under GUB Project 61 to improve the weathering qualities of the Kalewa char briquettes, or they will have to be transported and stored under cover with consequent added expense.

(2) Due to limitations imposed by the size of sample furnished and the funds made available, the laboratory investigations conducted in Germany did not progress to the point where the best process for beneficiating Kalewa coal could be selected and capital and operating costs estimated. Nevertheless, the results of the preliminary work confirmed results obtained in the United States, and hold forth the possibility of producing even better quality briquettes at costs not exceeding those estimated in the United States. In the tests in Germany, efforts were made to adapt to Kalewa coal several processes employed in European beneficiation practice. These included the following:

(*a*) Tests were performed to maintain the percentage of lump-size coarse coal by immersion in a solution of calcium chloride, Albert emulsion, magnesia solution, water glass, chlorine-magnesium solution and the like, which are traditionally approved means of preventing oxygen from entering the lumps.

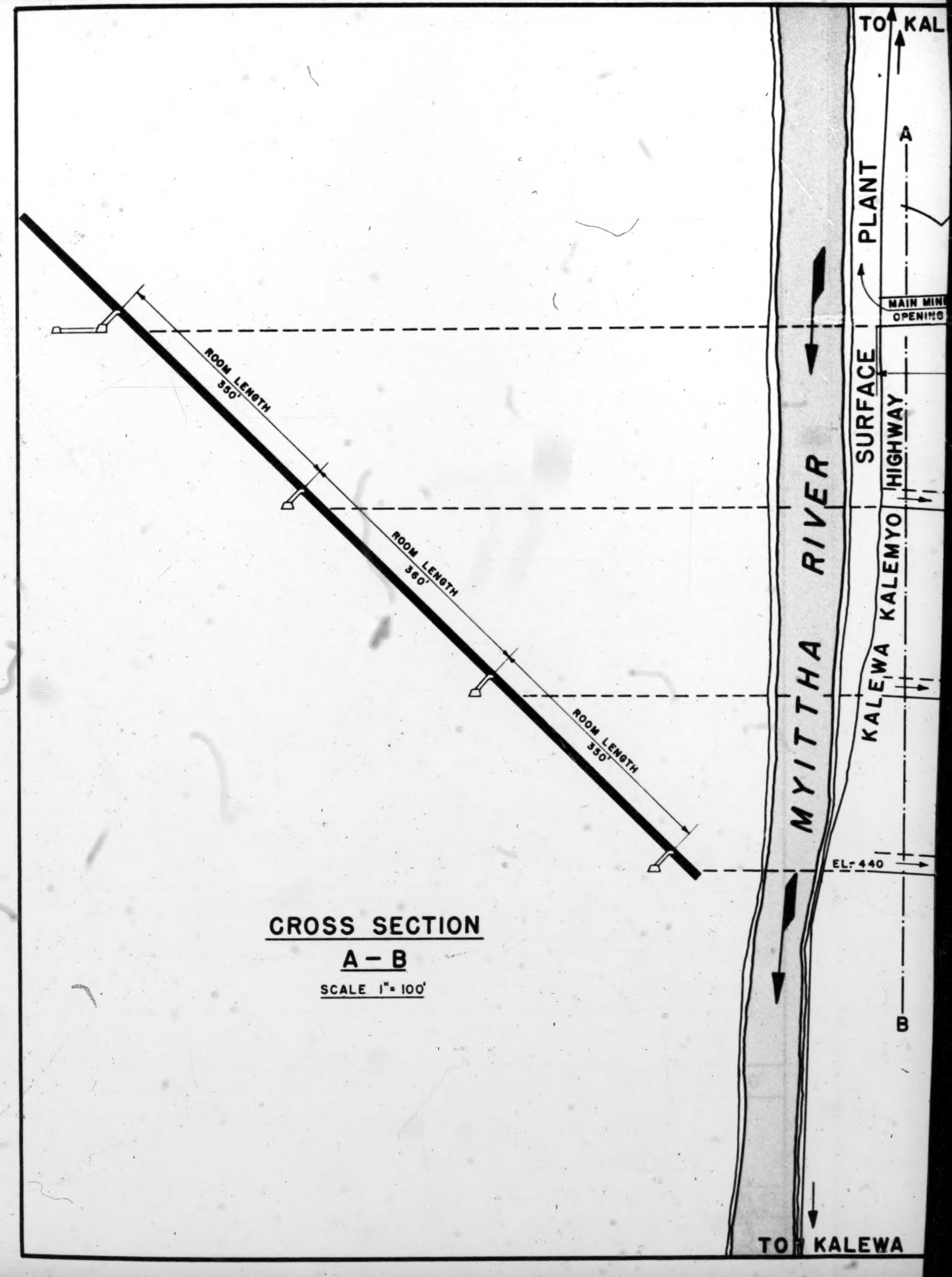
The variously treated lumps were then subjected to varying climatic conditions including an artificially generated tropical climate. Although the lumpy shapes were invariably maintained, the lumps in no case proved resistant to mechanical stress. It was concluded that the decomposition of Kalewa coal does not result largely from oxidation but rather that contraction through minor dehydration is responsible for the cracks which occur and result in disintegration to small sizes.

(*b*) Attempts were made to prepare binderless briquettes from Kalewa coal by utilizing high pressures and varying the water content, a method which has had wide application in Germany. The results were unsatisfactory in that the briquettes had insufficient strength.

(*c*) Numerous experiments in the preparation of egg shape briquettes in a roll press were unsatisfactory, even with the addition of up to 15% of binder, an unusually high percentage; separate tests were made both with coal and with char resulting from low temperature carbonization in varying degree of granulometric composition. The resultant briquettes appeared to have been subjected to insufficient pressure and had a specific gravity of 1·0, which is substantially lower than the usual value of 1·2 after briquetting.

(*d*) Utilizing a hydraulic ram press, briquettes of satisfactory strength were produced first from either coal or from char from low temperature carbonization with the addition of 15% of binder. Subsequent experimentation with admixtures of coal and char in various proportions and different granulometric composition resulted in the production of a briquette containing only 7% of binder which showed satisfactory strength and excellent combustion qualities.

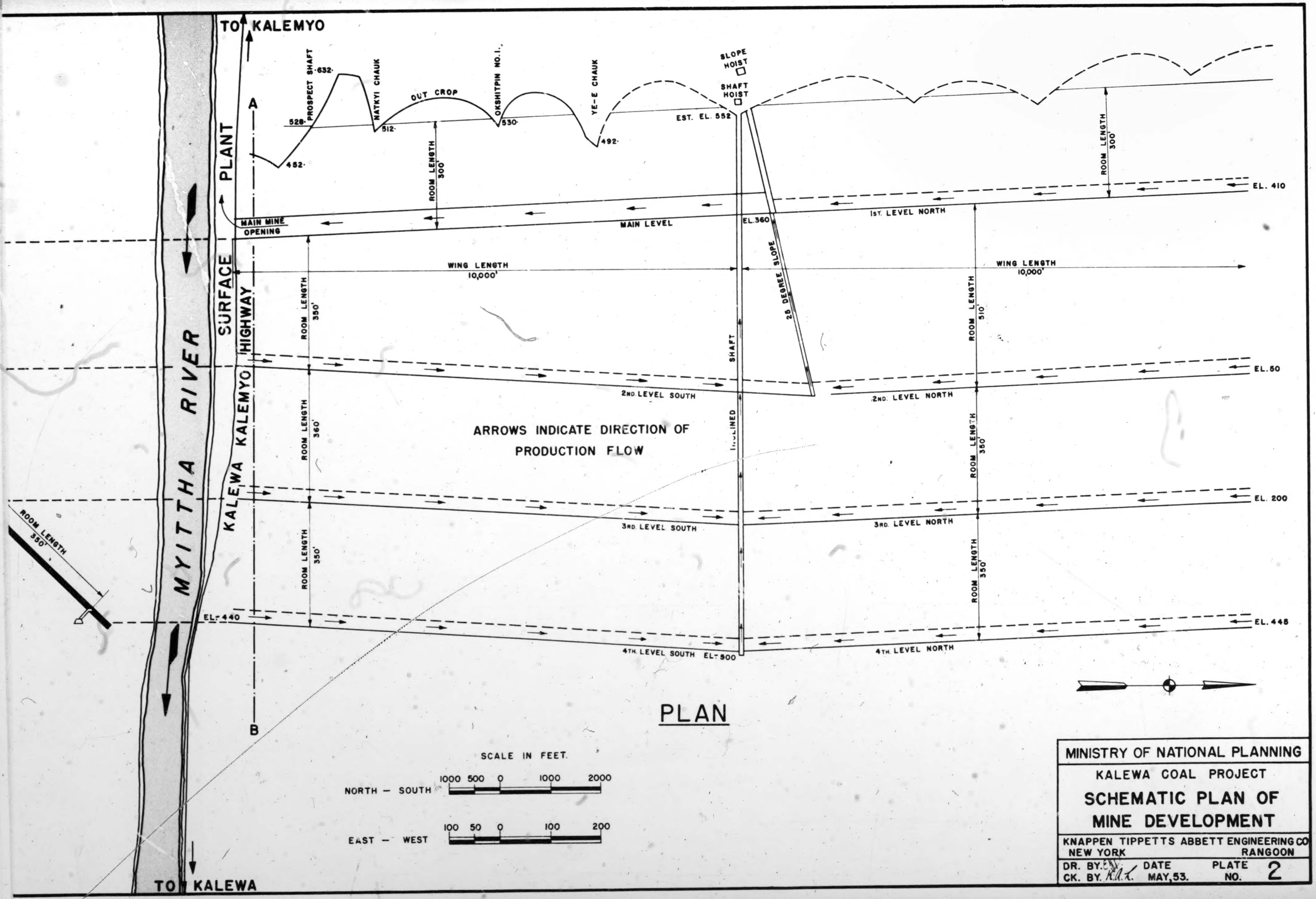
(*e*) The small scale tests carried out in Germany provide insufficient data for the design of a large commercial plant and, as a precautionary measure,


TO KAL
A
PLANT
SURFACE
MAIN MIN
OPENING
ROOM LENGTH 350'
ROOM LENGTH 360'
ROOM LENGTH 350'
MYITTHA RIVER
KALEWA KALEMYO HIGHWAY
EL. 440
B
TO KALEWA

CROSS SECTION

A – B

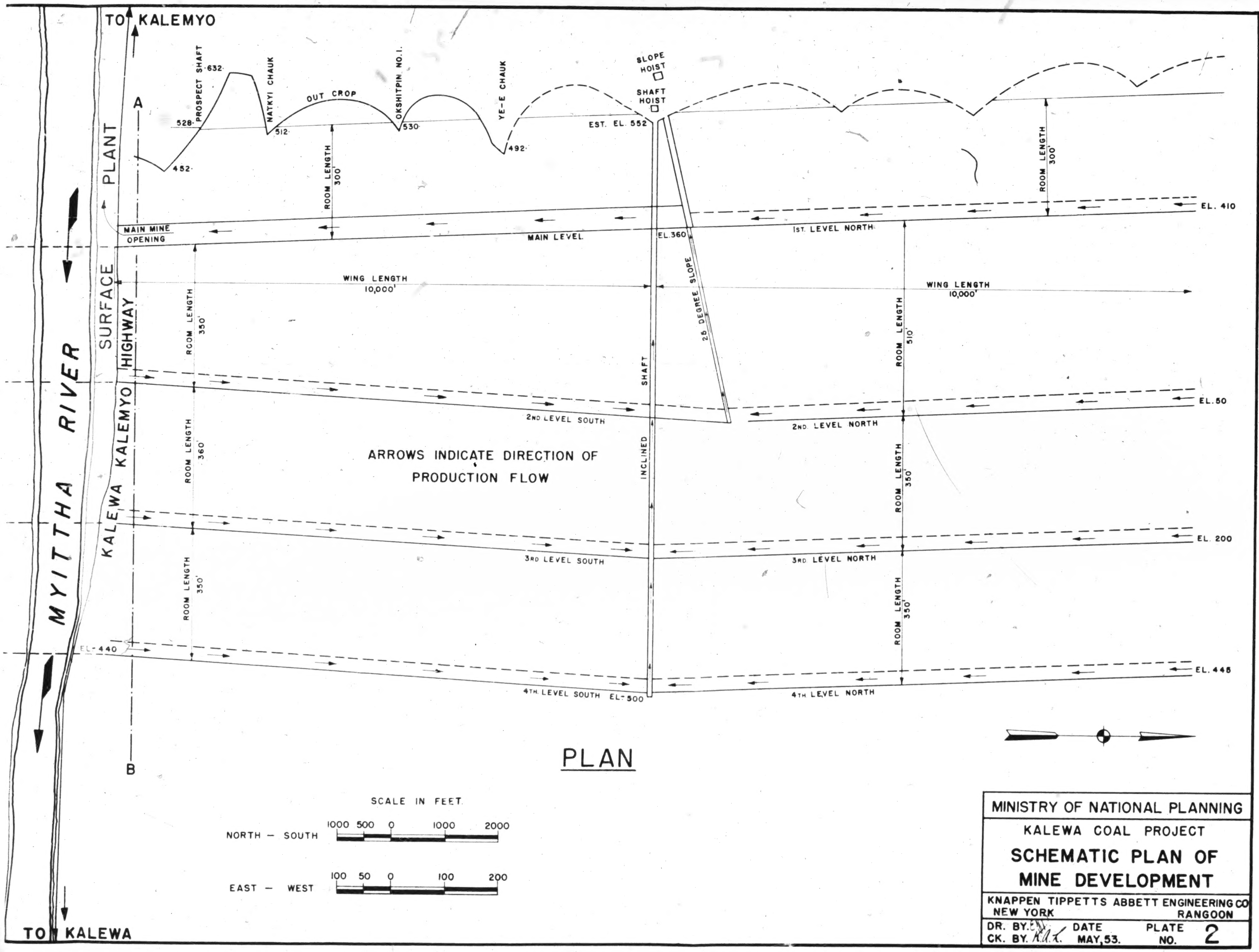
SCALE 1" = 100'


TO KALEMYO
PROSPECT SHAFT
632
528
452
NATKYI CHAUK
512
OUT CROP
OKSHITPIN NO. 1.
530
YE-E CHAUK
492
SLOPE HOIST
SHAFT HOIST
EST. EL. 552
A
B
PLANT
SURFACE
MAIN MINE OPENING
MAIN LEVEL
ROOM LENGTH 300'
EL. 360
1ST. LEVEL NORTH
EL. 410
WING LENGTH 10,000'
28 DEGREE SLOPE
SHAFT
INCLINED
ROOM LENGTH 350'
ROOM LENGTH 510'
ROOM LENGTH 360'
ROOM LENGTH 350'
2ND. LEVEL SOUTH
2ND. LEVEL NORTH
EL. 50
ARROWS INDICATE DIRECTION OF PRODUCTION FLOW
3RD. LEVEL SOUTH
3RD. LEVEL NORTH
EL. 200
EL. 440
4TH. LEVEL SOUTH
EL. 500
4TH. LEVEL NORTH
EL. 446
MYITTHA RIVER
KALEWA KALEMYO HIGHWAY
ROOM LENGTH 350'
TO KALEWA
SCALE IN FEET.
NORTH – SOUTH
1000 500 0 1000 2000
EAST – WEST
100 50 0 100 200

PLAN

MINISTRY OF NATIONAL PLANNING
KALEWA COAL PROJECT
SCHEMATIC PLAN OF MINE DEVELOPMENT
KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON

DR. BY.	DATE	PLATE
CK. BY. K.A.L.	MAY, 53.	NO. 2


TO KALEMYO
PROSPECT SHAFT
632
528
452
NATKYI CHAUK
512
OUT CROP
OKSHITPIN NO. 1.
530
YE-E CHAUK
492
SLOPE HOIST
SHAFT HOIST
EST. EL. 552
A
SURFACE PLANT
ROOM LENGTH 300'
ROOM LENGTH 300'
MAIN MINE OPENING
MAIN LEVEL
EL. 360
1ST. LEVEL NORTH
EL. 410
WING LENGTH 10,000'
WING LENGTH 10,000'
25 DEGREE SLOPE
ROOM LENGTH 350'
ROOM LENGTH 510'
MYITTHA RIVER
KALEWA KALEMYO HIGHWAY
INCLINED SHAFT
2ND LEVEL SOUTH
2ND. LEVEL NORTH
EL. 50
ROOM LENGTH 360'
ROOM LENGTH 350'
ARROWS INDICATE DIRECTION OF PRODUCTION FLOW
3RD LEVEL SOUTH
3RD LEVEL NORTH
EL. 200
ROOM LENGTH 350'
ROOM LENGTH 350'
EL-440
4TH. LEVEL SOUTH
EL-500
4TH LEVEL NORTH
EL. 445
B
PLAN
SCALE IN FEET
NORTH – SOUTH
1000 500 0 1000 2000
EAST – WEST
100 50 0 100 200
TO KALEWA

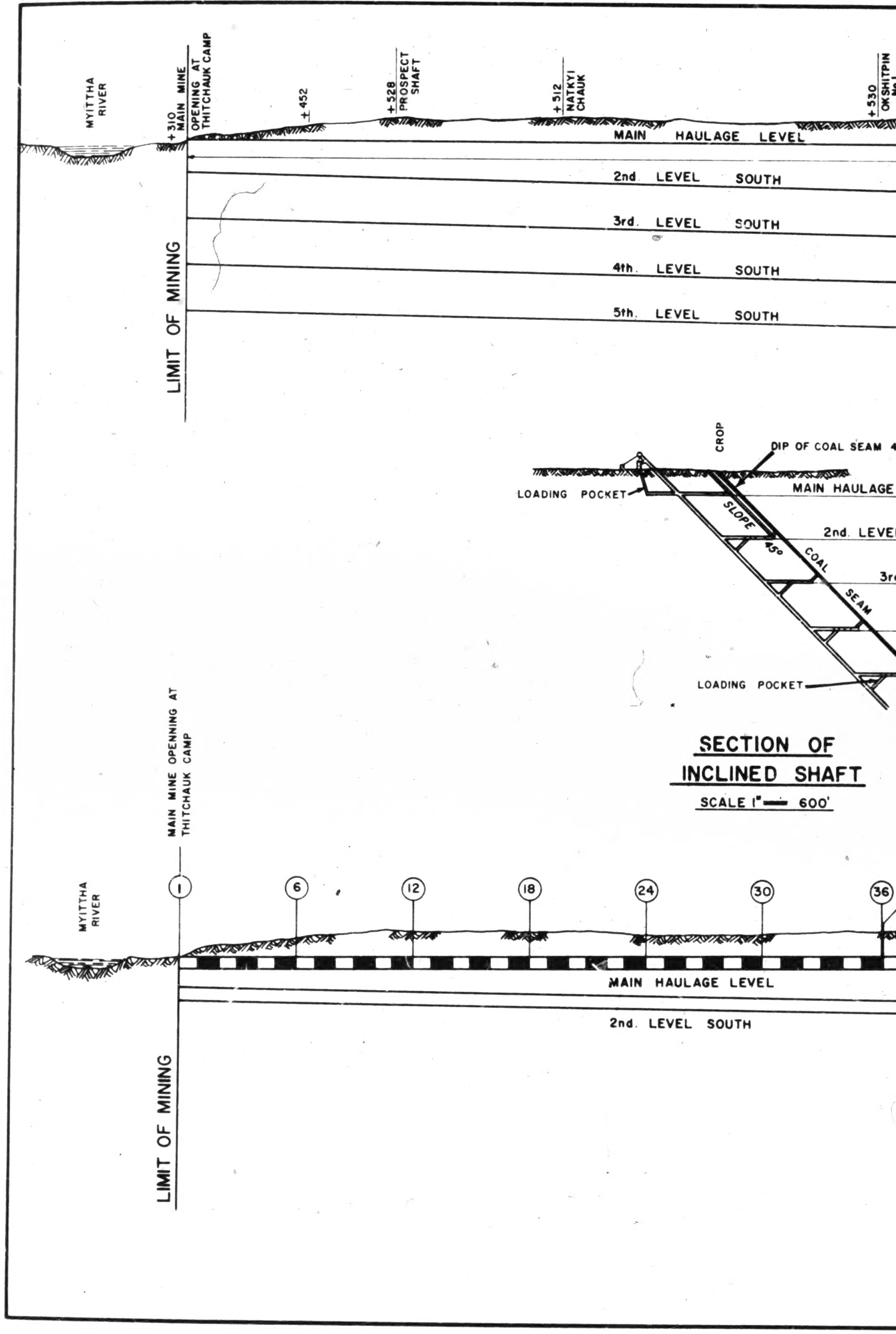
MINISTRY OF NATIONAL PLANNING

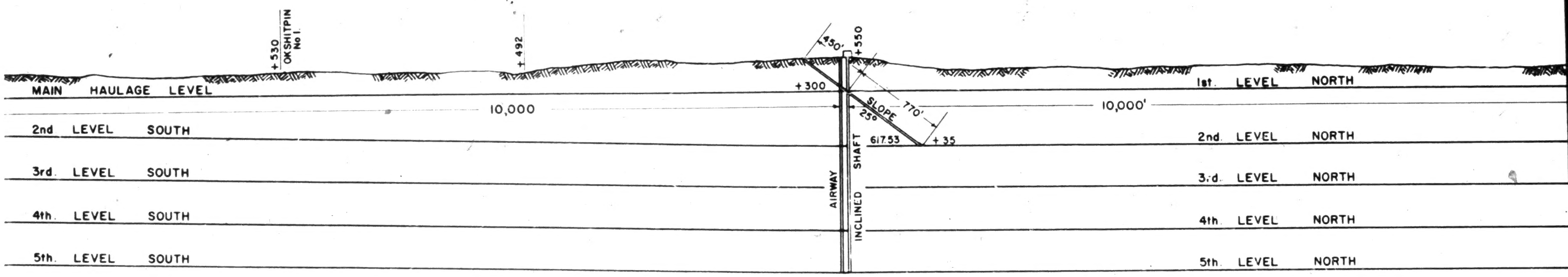
KALEWA COAL PROJECT

SCHEMATIC PLAN OF MINE DEVELOPMENT

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. DATE PLATE
CK. BY. R.A.L. MAY, 53. NO. 2

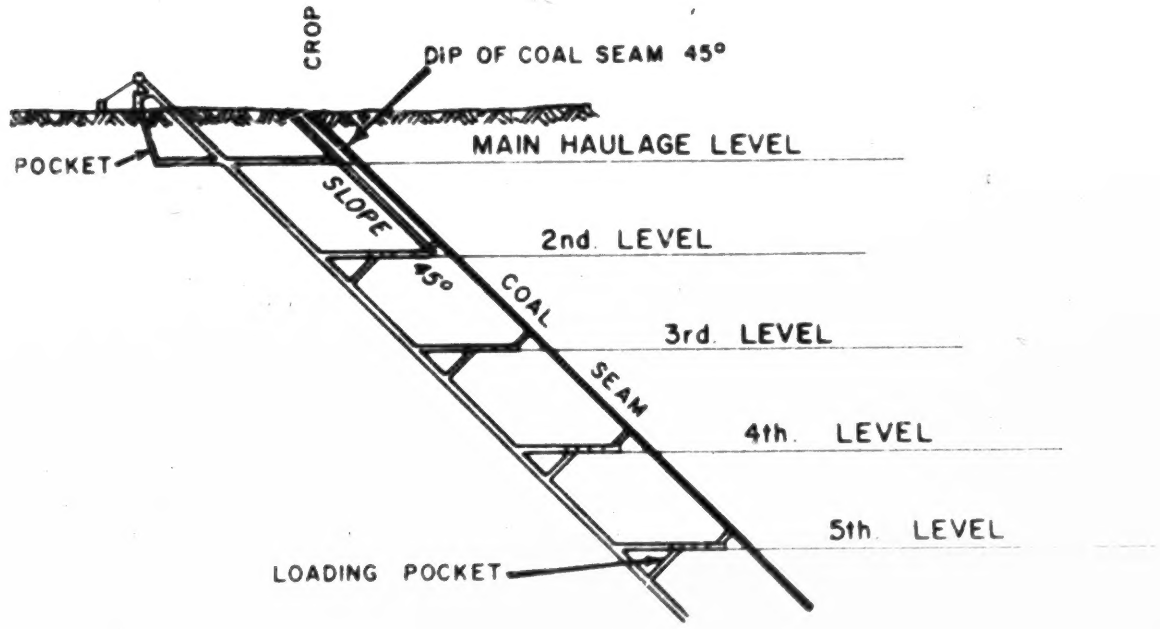

MYITTHA RIVER
+310 MAIN MINE OPENING AT THITCHAUK CAMP
±452
+528 PROSPECT SHAFT
+512 NATKYI CHAUK
+530 OKSHITPIN
MAIN HAULAGE LEVEL
2nd LEVEL SOUTH
3rd. LEVEL SOUTH
4th. LEVEL SOUTH
5th. LEVEL SOUTH
LIMIT OF MINING
CROP
DIP OF COAL SEAM 4
LOADING POCKET
MAIN HAULAGE
SLOPE
45°
COAL
SEAM
2nd. LEVEL
3r
LOADING POCKET
SECTION OF
INCLINED SHAFT
SCALE 1" = 600'
MYITTHA RIVER
MAIN MINE OPENNING AT THITCHAUK CAMP
1
6
12
18
24
30
36
MAIN HAULAGE LEVEL
2nd. LEVEL SOUTH
LIMIT OF MINING



+530
OKSHITPIN No 1
+492
450'
+550
+300
SLOPE 25°
770'
617.53
+35
10,000
10,000'
MAIN HAULAGE LEVEL
2nd LEVEL SOUTH
3rd. LEVEL SOUTH
4th. LEVEL SOUTH
5th. LEVEL SOUTH
1st. LEVEL NORTH
2nd. LEVEL NORTH
3rd. LEVEL NORTH
4th. LEVEL NORTH
5th. LEVEL NORTH
AIRWAY
INCLINED SHAFT

LONGITUDINAL SECTION SHOWING GENERAL MINE DEVELOPMENT

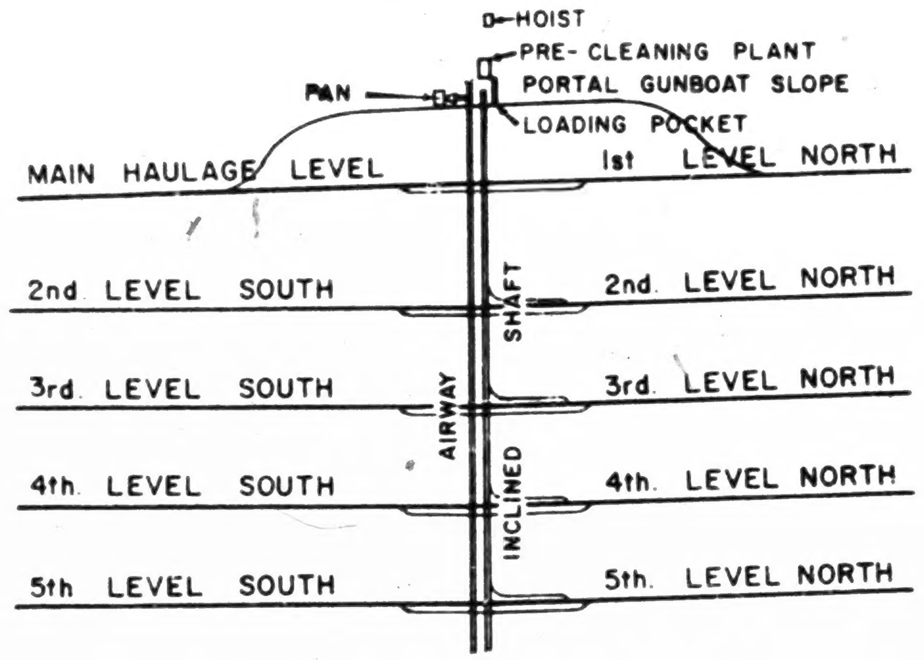
SCALE 1" — 600'



CROP
DIP OF COAL SEAM 45°
POCKET
MAIN HAULAGE LEVEL
SLOPE
45°
COAL SEAM
2nd. LEVEL
3rd. LEVEL
4th. LEVEL
5th. LEVEL
LOADING POCKET

SECTION OF INCLINED SHAFT

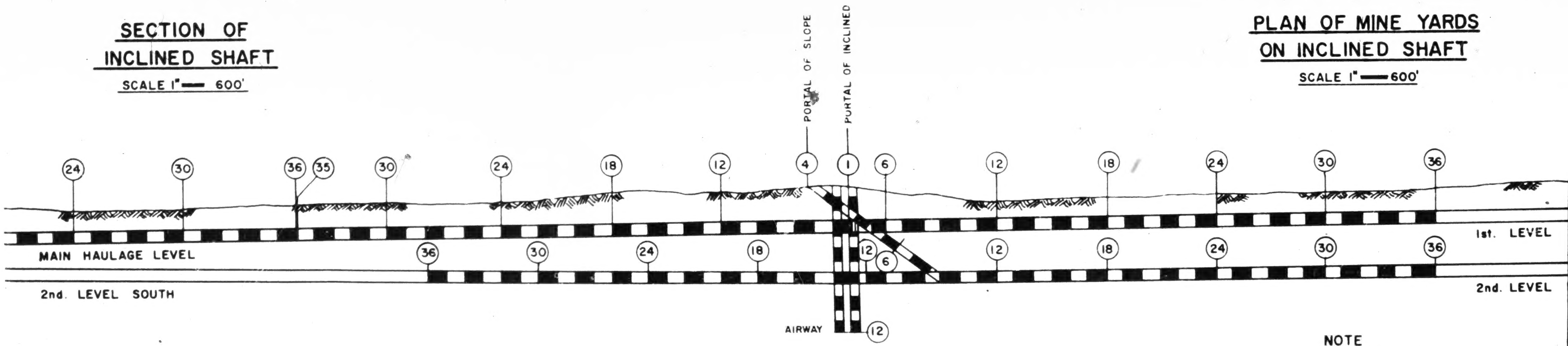
SCALE 1" — 600'



HOIST
PRE-CLEANING PLANT
PORTAL GUNBOAT SLOPE
FAN
LOADING POCKET
MAIN HAULAGE LEVEL
1st LEVEL NORTH
2nd LEVEL SOUTH
2nd. LEVEL NORTH
3rd. LEVEL SOUTH
3rd. LEVEL NORTH
4th. LEVEL SOUTH
4th. LEVEL NORTH
5th. LEVEL SOUTH
5th. LEVEL NORTH
AIRWAY
INCLINED SHAFT

PLAN OF MINE YARDS ON INCLINED SHAFT

SCALE 1" — 600'



PORTAL OF SLOPE
PORTAL OF INCLINED SHAFT
24
30
36
35
30
24
18
12
4
1
6
12
18
24
30
36
MAIN HAULAGE LEVEL
1st. LEVEL
36
30
24
18
12
6
12
18
24
30
36
2nd. LEVEL SOUTH
2nd. LEVEL
AIRWAY
12

NOTE

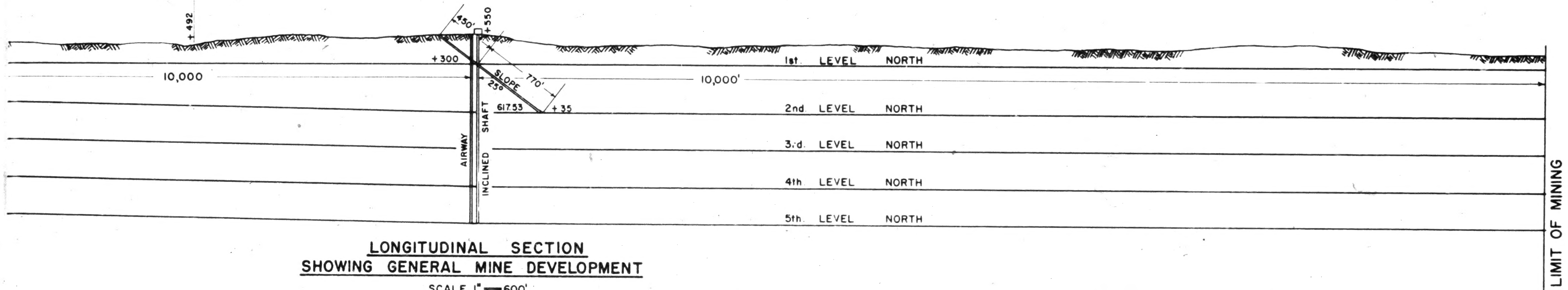
3rd 4th AND 5th NOT SHOWN
MONTHLY PROGRESS IS INDICATE
LEVELS AND NUMERICALLY BY
FIGURES ① TO ㊱

PROJECTED MINE DEVELOPMENT SCHEDULE

SCALE 1" — 600'

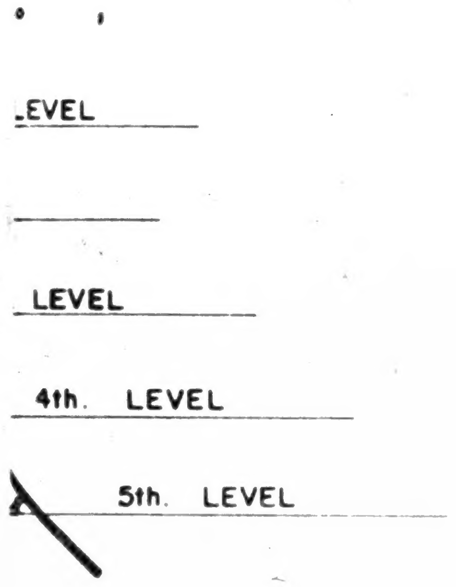
NOTE

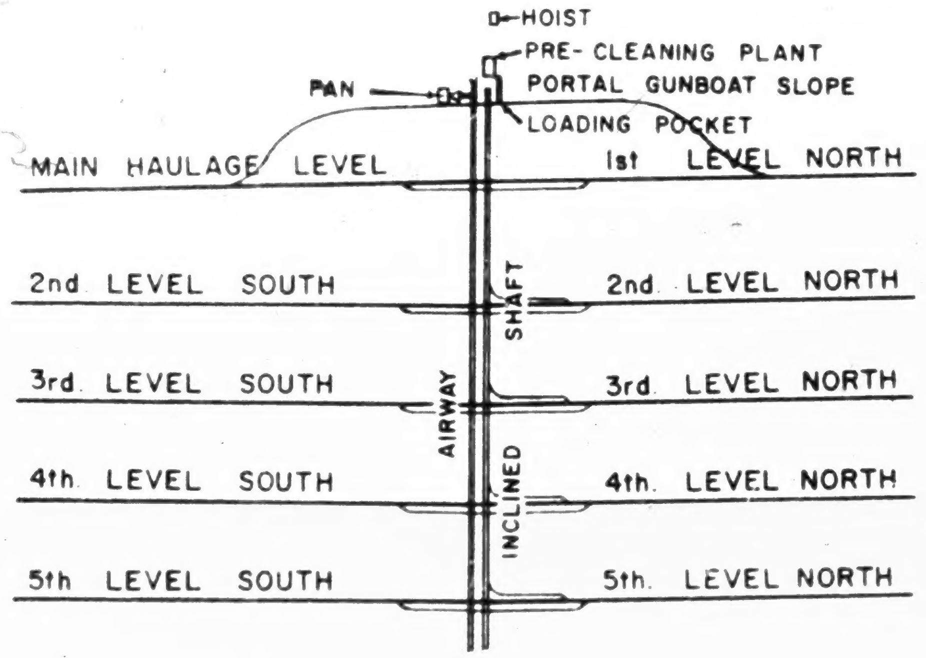
DEVELOPMENT STARTING IN FIRST MONTH ① AT PORTAL OF MAIN HAULAGE LEVEL NEAR MYITTHA RIVER AND FROM SURFACE AT SLOPE PORTAL.


+492
450'
+550
+300
10,000
10,000'
SLOPE
770'
25°
617.53
+35
1st. LEVEL NORTH
2nd. LEVEL NORTH
3rd. LEVEL NORTH
4th. LEVEL NORTH
5th. LEVEL NORTH
AIRWAY
INCLINED SHAFT
LIMIT OF MINING

LONGITUDINAL SECTION SHOWING GENERAL MINE DEVELOPMENT

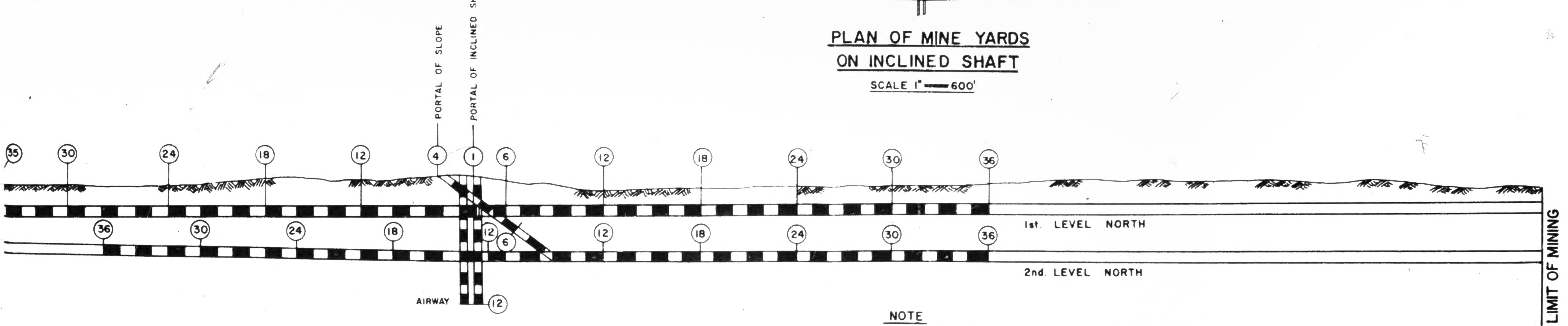
SCALE 1" = 600'


LEVEL
LEVEL
4th. LEVEL
5th. LEVEL


HOIST
PRE-CLEANING PLANT
FAN
PORTAL GUNBOAT SLOPE
LOADING POCKET
MAIN HAULAGE LEVEL
1st LEVEL NORTH
2nd LEVEL SOUTH
2nd. LEVEL NORTH
3rd. LEVEL SOUTH
3rd. LEVEL NORTH
4th. LEVEL SOUTH
4th. LEVEL NORTH
5th LEVEL SOUTH
5th. LEVEL NORTH
AIRWAY
INCLINED SHAFT

PLAN OF MINE YARDS ON INCLINED SHAFT

SCALE 1" = 600'


PORTAL OF SLOPE
PORTAL OF INCLINED SHAFT
35
30
24
18
12
4
1
6
12
18
24
30
36
36
30
24
18
12
6
12
18
24
30
36
1st. LEVEL NORTH
2nd. LEVEL NORTH
AIRWAY
12
LIMIT OF MINING

NOTE

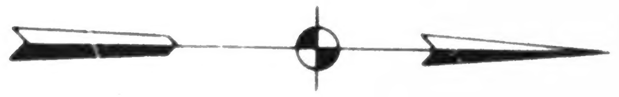
3rd 4th AND 5th NOT SHOWN ON THIS DRAWING
MONTHLY PROGRESS IS INDICATED BY BLOCKING ON LEVELS AND NUMERICALLY BY MONTHS BY THE FIGURES (1) TO (36)

PROJECTED MINE DEVELOPMENT SCHEDULE

SCALE 1" = 600'

NOTE

DEVELOPMENT STARTING IN FIRST MONTH (1) AT PORTAL OF MAIN HAULAGE LEVEL NEAR MYITTHA RIVER AND FROM SURFACE AT SLOPE PORTAL.



MINISTRY OF NATIONAL PLANNING

KALEWA
COAL PROJECT

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK. RANGOON.

DR BY. E. J. P. DATE PLATE
CK BY. K A L JULY. 53. NO. 3

large scale tests requiring from 100 to 200 tons of raw coal should be made and are contemplated in the continuing execution of Project No. 61.

(3) The Government Mining Adviser has forwarded samples of Kalewa coal to the Imperial Institute, Japan, for testing under the auspices of ECAFE. No information has yet been received of the results of these tests.

(4) Description of the Project

With confirmation of sufficient reserves by the diamond drilling program which has been initiated, and a favorable conclusion with respect to economic production of a stable char briquette, the establishment of a coal mining operation at Kalewa becomes feasible. The salient features of the development program presented in the project report are summarized in the following paragraphs.

(a) The basic factor determining the size of the initial mine operation at Kalewa is Burma's estimated solid fuel requirements as set forth in the preceding tabulation. The marketable products required, as shown therein, totalled 417,000 tons. To provide this tonnage, it will be necessary to develop a mine and construct beneficiation facilities capable of producing the tonnages shown in the following table.

TABLE XXI - 2

PRODUCTION CAPACITY - INITIAL PLANT

	1957	*1960*
	(tons)	(tons)
Run-of-mine production per day	2,500	2,500
Mine days per year	300	300
Run-of-mine production per year	750,000	750,000
Washed coal from cleaning plant-recovery 70%	525,000	525,000
Washed coal to be carbonized	275,000	275,000
Industrial briquettes produced	136,000	133,000
Metallurgical char produced	16,000	16,000
Metallurgical briquettes produced	15,000	17,000
Washed coal for market	250,000	250,000
Total marketable products	417,000	416,000

(b) In determining the best site for the development of the initial mine, that part of the Kalewa coalfield lying immediately north of the Myittha River and extending north therefrom for several miles, has been carefully explored and has been given detailed study and consideration.

In this area a balanced mine with wings extending 10,000 ft. to the north and to the south, with 15 ft. of workable coal extending to a depth of 1,000 ft. (equivalent to 1,400 ft. on the dip), would provide a reserve of 15,000,000 tons. The minimum recovery is estimated at 10,500,000 tons, indicating a mine life of 17 years at the prescribed rate of extraction.

In anticipation of the exhaustion of the reserves in the initial mine, underground development could be extended an additional 20,000 ft. north to provide a second similar mine which could be served by the same surface plant, thus increasing the life of the operation to 34 years.

(c) Mining methods will be used which have proved effective in similar steeply dipping seams from standpoints of safety, economy and flexibility of operations. During the period of underground development and plant construction, diesel driven electric generators, air compressors, fans, hoists and other equipment will be required. Diesel generated power will subsequently be supplanted when steam generated electric power becomes available from the mine power plant which will meanwhile be under construction.

The major underground development will be driven at a level approximately 20 ft. below the 10 ft. thick main coal seam. It will be a water level tunnel with an accompanying airway advanced northward from the main mine opening in the vicinity of Thitchauk Camp for the full 20,000 ft. length of the area to be developed. It will serve as the main haulage way for the transportation of production from the entire area to the surface plant. Midway along its length it will be intercepted by a 25 degree slope, sunk from the surface in the footwall of the seam and continuing to a lower level.

A development advancement rate of not less than 2,000 ft. per year is anticipated in both the haulageway and parallel airway. At this rate they will connect the main mine opening with the 25 degree slope within a period of three years, as illustrated in Plate 2. Subsequently, the lower levels will be developed by an inclined shaft which will be equipped with large capacity skips fed from suitable bins and loading pockets in order to facilitate extraction and hoisting operations. The complete development is illustrated in Plate 3.

The development work will be accomplished with the use of modern rock drilling equipment mounted on suitable rigs or jumbos. After blasting, the rock will be loaded into mine cars by power shovels for haulage to the surface by electric locomotives and appropriate disposal as waste rock. Electric hoists will serve haulage requirements on both the slope and the inclined shaft.

The extraction of coal from the main seam will be accomplished through rock holes from the underlying tunnels. The coal will be mined in panels by a modified room and pillar method and without the use of explosives. Pneumatic pickhammers will be used. It is anticipated that the coal extracted from the seam will be contaminated by the admixture of some 20% of rock from above and below the seam. The rock will be removed from the coal in a surface cleaning plant as the initial step in preparing the coal for marketing or beneficiation.

(d) The estimated work force required underground for the production of 2,500 tons of run-of-mine coal per day is as follows:

Underground	*No. of Employees*
Mining and Development in Coal	480
Development in Rock	36
Transportation and Supplies	167
Maintenance	48
Miscellaneous	13
Supervision and Clerical	30
Total Underground	774

(e) Surface plant installations and facilities will comprise the following items:

(1) A coal cleaning plant for the removal of admixed waste rock from the 2,500 tons per day of run-of-mine coal extracted. This will yield 1,750 tons of washed coal. Adequate coal storage facilities will be required to provide for continuity and flexibility of surface operations.

(2) A steam electric power plant, machine shop, electric equipment servicing shop, welding shop, carpenter shop, compressed air plant, mine ventilation fans, hoist house, storehouses, warehouses, and general offices for supervisory, administrative, clerical and engineering services will be required.

(3) Change and wash houses will be provided for the use of underground and surface employees as well as first aid and out-patient dressing stations.

(4) A pumping station and water purification plant will be required to provide water from the Myittha River for use in the boiler plant, in the coal cleaning plant, for fire protection and for general community use.

(5) Living quarters will have to be provided in the mine area for all employees and staff, the great majority of whom will have to be recruited from outside the immediate area. Adequate water supply, sanitation, hospital services, health, educational, religious and recreational facilities will have to be provided, as well as markets and bazaars from which food and living supplies may be obtained.

(6) The estimated surface working force, exclusive of personnel required for beneficiation of the coal, is estimated as follows:

Surface Plant	*No. of Employees*
Coal Washery – Double Shift	40
Storage Piles and Conveyors	20
Outside Transportation	32
Shops and Maintenance	30
Miscellaneous	166
Supervision and Clerical	48
Total Surface Plant	336

(7) *Coal processing and beneficiation plants* will be required for preparing Kalewa coal for utilization on conventional grates, particularly for railway locomotives and river boats, and for metallurgical usages.

The estimated force required for the beneficiation of Kalewa coal is as follows:

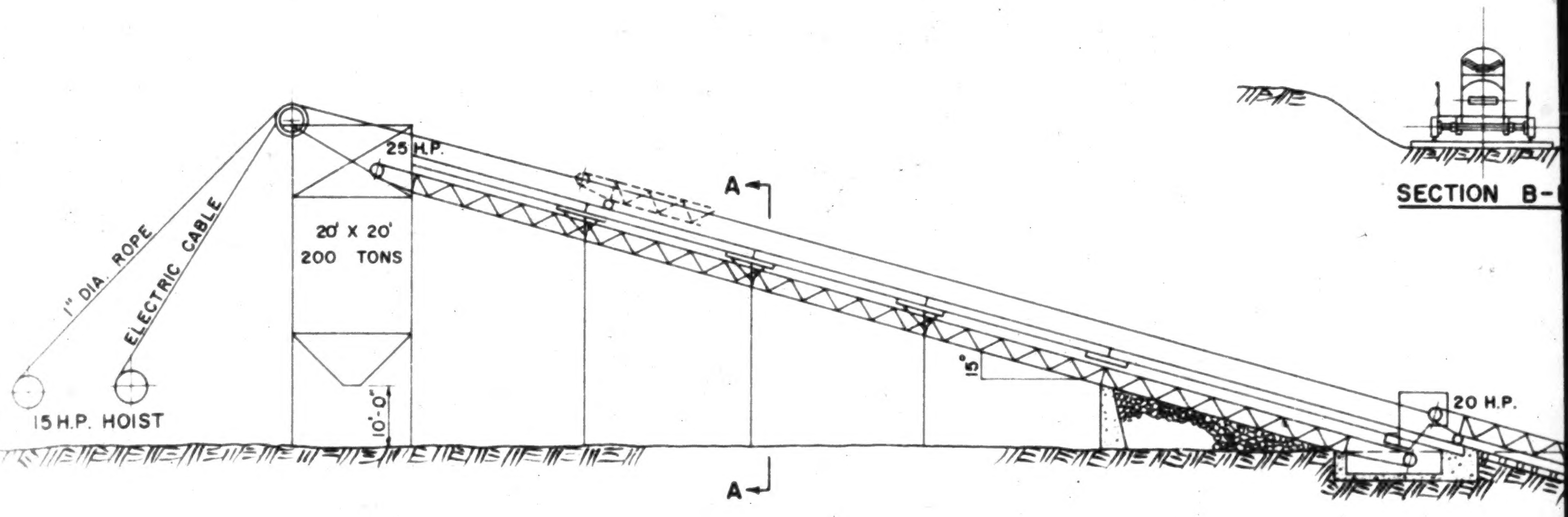
Beneficiation Products	*No. of Employees*
Char Briquettes (Industrial Briquettes)	190
Metallurgical Carbon (Metallurgical Char)	19
Metallurgical Coke (Metallurgical Briquettes)	65
Total, Beneficiation Plants	274

(8) *Engineering and management* should be provided by a competent and well qualified firm which supplies mining consultant, engineering and managerial services until such time as suitable trained indigenous technical and supervisory personnel become available. Similarly, experienced technicians and supervisors will be required during the initial period of operation of the beneficiation plants, not only for operation but also to provide instruction and training for Burmese counterpart personnel.

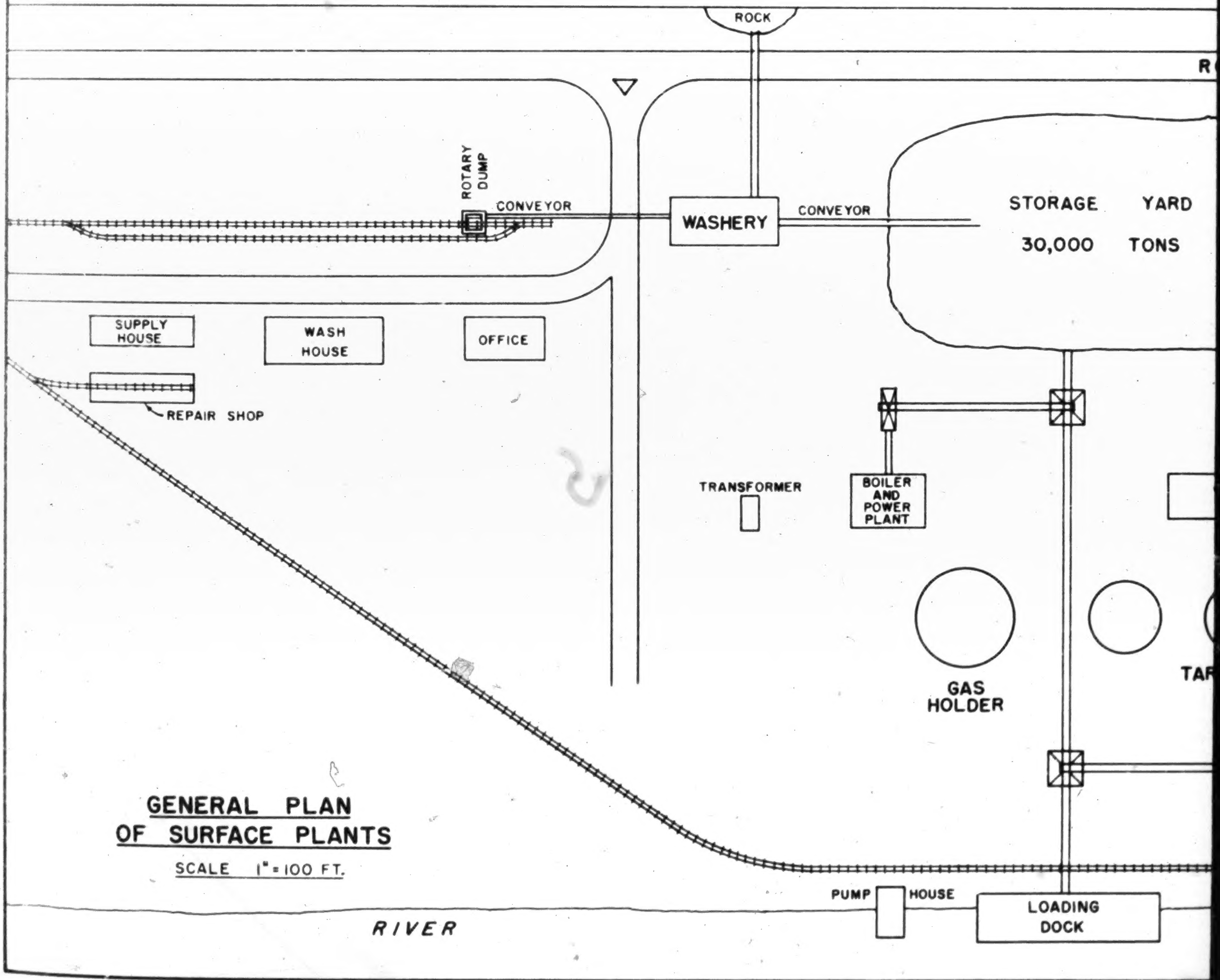
(9) *River transport facilities* for moving Kalewa products to market are to be provided as detailed in Appendix M in the project report. Entailed will be a barge-loading station located on the Myittha River near the mine plant where accommodation will have to be provided for a seasonal variation of nearly 50 ft. in river elevation. This station will be installed as illustrated in Plate 4. Barges of 280 tons capacity will be loaded here and moved in groups by towboats along the Myittha to desired destinations on the Chindwin and Irrawaddy Rivers. Barge unloading facilities, likewise designed to accommodate the variations in river elevations, will be provided at main delivery points as illustrated in Plate 4.

River Transport costs have been estimated as follows:

From	*To*	*Miles*	*Kyats per ton*	*Kyats per ton-mile*
Kalewa	Myingyan (downstream)	208	14.91	·0717
Kalewa	Mandalay (,,)	280	19.15	·0684
Myingyan	Rangoon (,,)	458	20.84	·0455
Kalewa	Rangoon (,,)	666	35.75	·0537
Rangoon	Myingyan (,,)	458	19.27	·0421


1" DIA. ROPE
ELECTRIC CABLE
15 H.P. HOIST
20' X 20'
200 TONS
10'-0"
25 H.P.
A
A
15°
20 H.P.
SECTION B-

METHOD OF UNLOADING BARGES


ROCK
R
ROTARY DUMP
CONVEYOR
WASHERY
CONVEYOR
STORAGE YARD
30,000 TONS
SUPPLY HOUSE
WASH HOUSE
OFFICE
REPAIR SHOP
TRANSFORMER
BOILER AND POWER PLANT
GAS HOLDER
TA
PUMP HOUSE
LOADING DOCK
RIVER

GENERAL PLAN OF SURFACE PLANTS

SCALE 1" = 100 FT.

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COAL PROJECT

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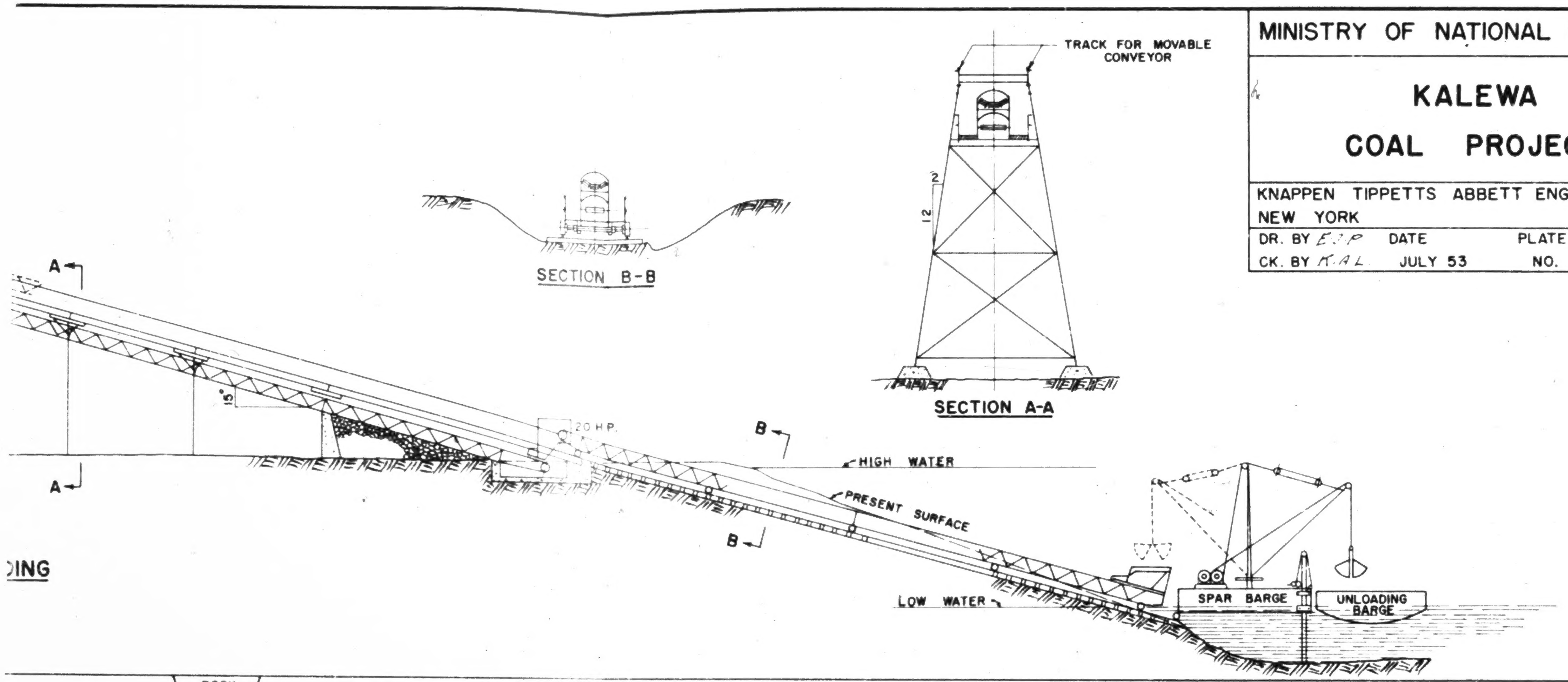
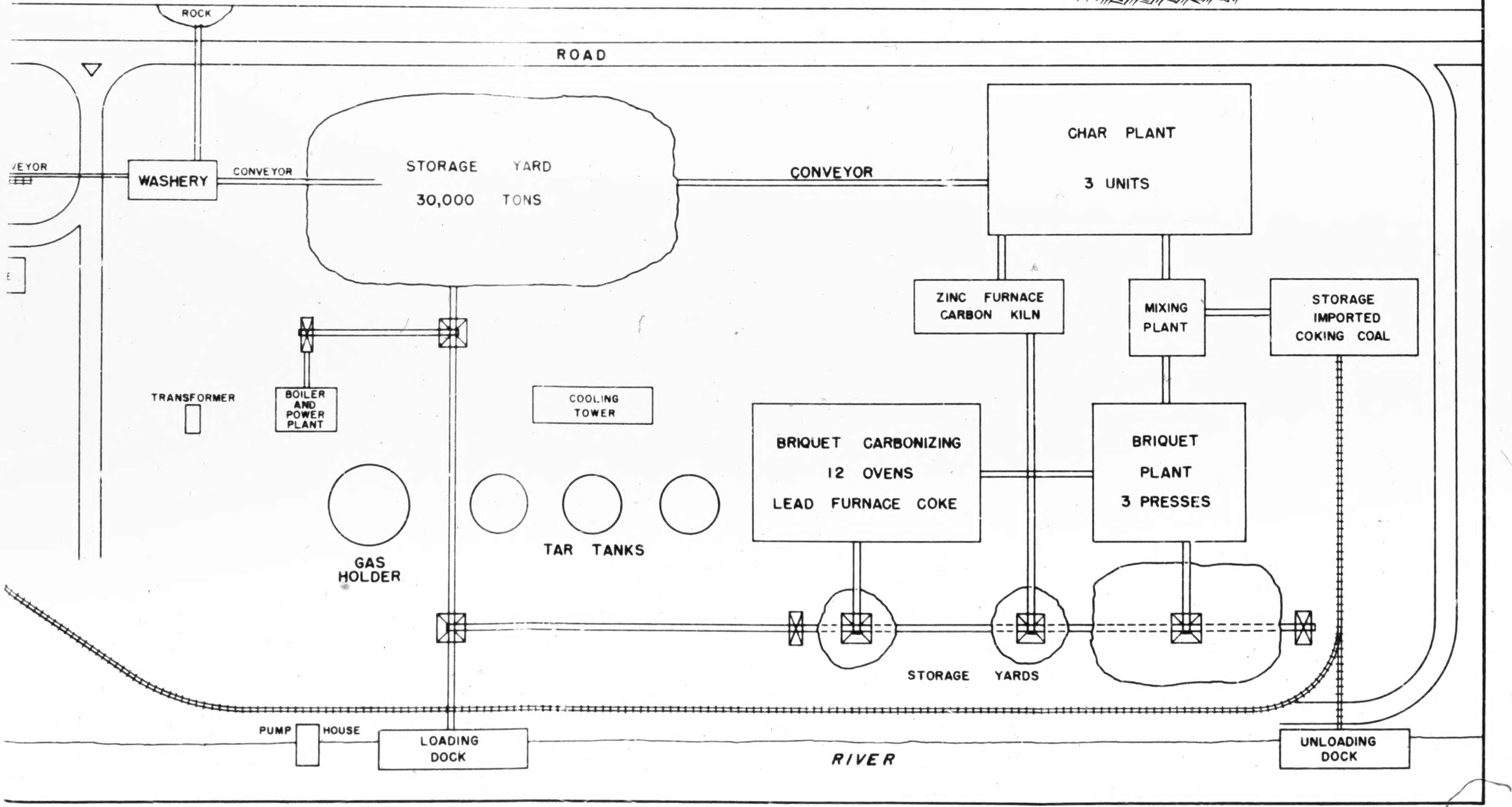
DR. BY E.J.P.	DATE	PLATE
CK. BY K.A.L.	JULY 53	NO. 4


TRACK FOR MOVABLE CONVEYOR
2
12
SECTION A-A
SECTION B-B
A
A
B
B
15
20 H.P.
HIGH WATER
PRESENT SURFACE
LOW WATER
SPAR BARGE
UNLOADING BARGE
DING


ROCK
ROAD
VEYOR
WASHERY
CONVEYOR
STORAGE YARD
30,000 TONS
CONVEYOR
CHAR PLANT
3 UNITS
ZINC FURNACE
CARBON KILN
MIXING PLANT
STORAGE IMPORTED COKING COAL
TRANSFORMER
BOILER AND POWER PLANT
COOLING TOWER
BRIQUET CARBONIZING
12 OVENS
LEAD FURNACE COKE
BRIQUET PLANT
3 PRESSES
GAS HOLDER
TAR TANKS
STORAGE YARDS
PUMP HOUSE
LOADING DOCK
RIVER
UNLOADING DOCK

(5) Estimated capital and production costs

Estimated capital and production costs for the program of mine development and plant construction outlined in the foregoing section (4) may be summarized as follows:

(a) Estimated cost of mine development and plant construction:

TABLE XXI – 3

ESTIMATED COST—MINE DEVELOPMENT AND PLANT CONSTRUCTION

Item Description	*Estimated Cost*	
	Dollars	*Kyats*
Development and Construction	1,897,617	26,45,900
Mine Equipment	1,083,500	—
Outside Buildings	25,000	8,05,000
Power Facilities	1,183,000	18,60,000
Communication Facilities	60,000	4,25,000
Washery, Storage, Dock Facilities	825,000	15,30,000
Beneficiation Plant	2,010,000	50,00,000
Housing and Community	169,000	56,40,000
Engineering and Management	1,700,000	16,30,000
Spare Parts	400,000	—
Ocean and River Freight	350,000	6,00,000
Contingencies	923,800	19,98,300
Total Mine and Plant	10,626,917	2,21,34,200
Total, Equivalent Dollars	15,286,748	—
Total, Equivalent Kyats	—	7,26,12,056

If, in place of barge transportation, railway transportation and distribution from a point opposite Kalewa on the east side of the Chindwin River were to be used, an aerial tramway from the mine to that point and the construction there of railway loading facilities would cost an additional $532,050 and K12,34,820 compared with the cost of barge-loading and unloading facilities.

(b) Estimated capital cost of river transport facilities and conservancy. The capital cost for the establishment of river barge transportation facilities and conservancy has been estimated at K5,14,36,495 (Appendix M, Project Report).

(c) **Production costs,** for various Kalewa products, loaded on river barges at the mine, have been estimated as follows:

Washed Coal For use in stationary boilers equipped with spreader stokers or for burning in suspension.	K22.54 per ton
Industrial Briquettes For use on railway locomotives, river boats and in boilers equipped with stationary grates.	K44.14 per ton
Metallurgical Char A metallurgical carbon for use in the reduction of zinc ores and concentrates.	K53.68 per ton
Metallurgical Briquettes A metallurgical coke for use in the blast furnace smelting of lead ore.	K111.25 per ton

(6) Economic Justification

(a) The future of coal in Burma. Increasingly in recent years, coal has become overshadowed as the principal source of energy and power for heat by the advent of oil, natural gas and hydroelectric power. Additionally, there are now the possibilities envisaged in development of atomic energy for industrial uses which could well materialize with unexpected rapidity. These trends away from coal as the principal source of energy are fully recognized. The development of hydroelectric plants is projected, dieselization of transport equipment on railways, river-boats and ocean-going ships is under way, and limited use is being made of natural gas.

However, there are numerous requirements in the industrial and metallurgical fields that must or can best be met by coal or other solid fuels. There are also circumstances under which the use of coal is desirable from the standpoint of economics. While dieselization of motive equipment generally results in operating economies, it is well to keep in mind the limited reserves available in Burma's oilfields, the proven extent of which would serve the country's estimated requirements of petroleum products for only 25 years. The development of additional production and the discovery of new oil reserves will entail large rehabilitation and exploration expenditures.

Should the explorations prove fruitful there still remains the desirability of conserving the oil supply to effect self-sufficiency for the longest possible period of time. Should unusually large reserves be discovered, any exportable excess would bring in new foreign exchange balances.

The utilization of natural gas is necessarily limited. No substantial sources of natural gas have been discovered, and it need not be further considered at this time. The development of hydroelectric plants is primarily for power purposes. Utilization of electric energy for heat is uneconomic and generally does not compete with coal for this purpose. Coal-steam-electric plants may be located beyond the distribution field of hydroelectric plants or may be tied in to the distribution system to supplement the latter source.

With the consideration of all the foregoing factors it is adjudged that Burma will continue to require substantial quantities of coal and other solid fuels for industrial and metallurgical purposes, for certain electric power establishments, and for reduced railway requirements and other general purposes.

Prewar and presently, Indian coal has been imported as required. Arrangements are being made by the Union of Burma Shipping Board to establish a fleet for the ocean transport of 180,000 tons per year of Indian coal, indicating its continued importation. Rehabilitation of Burma to prewar conditions only would greatly increase her coal requirements; with the transport, power, industrial and metallurgical expansions projected, her requirements for coal and other solid fuel will increase tremendously. To import this additional tonnage from India or elsewhere would adversely affect foreign exchange while continuing and even increasing Burma's dependency on other nations.

(b) Justification for the Kalewa development project. (1) The foreign exchange benefits which Burma would derive from the projected use of Kalewa coal, based on its 1951–52 purchases of Indian coal, are estimated at K1,30,00,000 using present (June 1953) prices and at K99,00,000 using the optimum Indian coal prices estimated when Burma operates its own coal-carrying vessels. On the basis of the estimated solid fuel market to be served by Kalewa in 1960, the foreign exchange benefit increases to K2,93,00,000 with present prices of Indian coal, and to K2,22,00,000 if the optimum estimated price of Indian coal is realized.

(2) Kalewa coal will be used to greatest economic advantage when burned as a pulverized fuel in central Burma. Any departure from this optimum condition produces lesser economic benefits.

(3) During the initial years of production operations, Kalewa coal and industrial briquettes must largely be disposed of in their most unfavorable market, namely the Rangoon area. Based upon 1951–52 purchases by users and upon the present price of Indian coal at Rangoon (June 1953), Kalewa coal can enter this area on the competitive basis shown in Table 1 and 2 of Appendix E of the project report. Based on realization of the optimum estimated future price of Indian coal at Rangoon, Kalewa coal and briquettes would cost, on an equivalent heat value basis, approximately K13.00 more per ton than Indian coal, as shown in Table 2, Appendix E of the project report.

(4) The economic justification for developing early production from the Kalewa coalfield is based largely upon the following facts:

(*a*) The saving in foreign exchange.

(*b*) Realization of the estimated optimum future price of Indian coal cannot be definitely assured. No one can predict the price of Indian coal several years in advance. The price may be affected by internal conditions in India or by demand of other nations for available Indian coal supplies.

(*c*) Based on Burma's projected needs, the proposed Kalewa development will not be able to supply all of her solid fuel requirements. If the Kalewa deposit is developed Burma will have an alternative source of coal and can bargain more effectively for its imports. This factor alone might soon enable return of the investment required

(*d*) The benefits to be derived from industrial expansion in central Burma are substantial, and to meet the need of industries such as the zinc refinery, low cost coal is essential.

(*e*) As the hydroelectric power potential of central Burma is utilized, the need for steam generated power to supply deficiencies in unusual dry years or when hydroelectric construction lags will become apparent.

(*f*) The additional employment of Burmese nationals which the Kalewa operation would entail and the increased economic activity which would be generated by such a payroll could well be a major advantage of the project as compared to offshore purchases. Mining is usually the vanguard of other industry and from it are learned many rudimentary techniques from which labor advances to work requiring greater skills and technology.

(*g*) National self-sufficiency in times of international disturbances could in itself be considered a decisive economic factor.

(*h*) The wage rates used in the Kalewa estimates and the cost of riverine transport have been conservatively estimated. Actual mine and waterway operations may well demonstrate lower costs.

(*i*) Daily year-round transportation on the Chindwin River to Kalewa would initiate other activity in the tributary areas.

(*j*) The value of the by-products of the low temperature carbonization process have been stated in the project report at a nominal amount only. As Burma develops, the manufacture of important coal-derived chemical and medical products will follow. Burma's ammonia requirement for fertilizer can be met through the use of Kalewa coal and sulphuric acid from the zinc refinery which the coal will make possible.

(*k*) There is no evidence that a coalfield superior to Kalewa may be found in Burma.

(*l*) Productive results from extensive oil exploration may not be forthcoming for a number of years.

Meanwhile Burma will barely be able to provide its minimum domestic oil needs and coal-generated power will be required wherever its production is most feasible.

(m) The development of a mine of less capacity than that projected has been examined and found unattractive. The proposed coal mining operation at Kalewa is already comparatively small and at the point where smaller capacity would increase unit costs substantially. If unexpectedly, during the initial years of operation, all the normal production cannot be used advantageously, production can be better regulated by working one shift per day and, should further reduction be required, a shorter work week. Under such circumstances, operating economies obtainable under single shift operation would defray part of the increased fixed charges and additional productive capacity would be available as needed.

(7) Conclusions and Recommendations

(a) If the estimated optimum future price for Indian coal at Rangoon should be realized and should prevail for an extended period, the excess cost of Kalewa fuels over Indian coal could reach a substantial amount. This condition, however, would not be permanent because Kalewa production would all be gradually absorbed in the expanding central Burma market, thus releasing the Rangoon area to Indian coal.

(b) An alternative to developing Kalewa coincidentally with the industrial program projected for central Burma would be the importation of Indian coal into the area during the expansion period, postponing the development and the investment entailed until demand became sufficient to absorb the maximum Kalewa output. The alternative is not attractive inasmuch as the extra costs arising from the increased prices that would have to be charged for Indian coal delivered to central Burma, even with the optimum price, would be considerably in excess of the extra cost of Kalewa coal sold during a similar period in the Rangoon area.

(c) Ample economic justification for the early development of Kalewa production can be had in national self-sufficiency, savings in foreign exchange, employment of local labor and the development of mineral industry projects, such as the Myingyan zinc refinery and the Lough Keng zinc mine ore deposit, and the other planned industrial projects dependent upon Kalewa coal for power and fuel.

(d) Therefore, because the development of the Kalewa coalfield is an essential part of an integrated industrial program for central Burma, and considering that the advantages of early development outweigh by far any advantages to be gained by postponement, this development should be undertaken as the first stage of such a program. When sufficient coal reserves are confirmed by the drilling program now under way, and when a suitable briquette has been developed, the Kalewa project should go forward with highest priority.

(e) It is presumed that the Mineral Resources Development Corporation will be given the responsibility for securing execution of the Kalewa coalfield development project. It is strongly recommended that the Corporation secure the services of a well qualified firm which provides mining consultant, engineering and management services for implementation of the development program during the initial stages and to direct and manage operations until suitably trained indigenous technical and supervisory personnel become available.

(f) It is further recommended that the responsibility of the Mineral Resources Development Corporation include securing the establishment and operation of facilities required to carry Kalewa production to the various market distribution points, inasmuch as the provision and operation of transport facilities exclusively for this purpose will be required. Under such circumstances, incentive for economic and efficient transport service is presented only to the operator of the mine, namely the Mineral Resources Development Corporation.

(g) It is recommended that the necessary labor force, which is not available in the immediate vicinity in sufficient number and will have to be recruited from considerable distances, be carefully selected and trained, and the adaptability to underground employment be promptly assessed. Should it be determined that indigenous mine labor does not respond effectively or in sufficient number, it is recommended that consideration be given promptly to the temporary importation of adequate foreign labor to the extent required for efficient mine operation.

b. The Myingyan Project

(1) Introduction

The Myingyan project presented in the preliminary report envisaged the development at Myingyan of an industrial center which would serve a number of industries that might be established there advantageously because of the combination of cheap fuel and electric power from Kalewa coal and convenient river and rail transportation for both raw materials and finished products. Most important among these industries was a zinc smelter and refinery and the coal burning electric power plant essential to it. The project now under discussion relates only to the zinc reduction plant. The coal burning steam power plant is described in Chapter XIX, para. E-2. The zinc plant will utilize approximately 10,000 kW of the steam power plant capacity, representing a capital investment of about $2,000,000. The rate of one cent per kWh to the zinc plant has been calculated to fully cover all power plant costs, including return of investment.

(2) Summary

(a) Objective and general description. The objective of the project is the establishment at Myingyan of a profitable zinc smelting and refining industry based on fuel and electric power to be afforded by Kalewa coal, zinc concentrates to be supplied by Burma Corporation and zinc ores provided by the exploitation of the Lough Keng deposit.

A project report has been prepared and submitted to the Government under date of March 31, 1953 entitled "Myingyan Zinc Project." The report sets forth objectives, reviews field and laboratory investigations to date, describes the project and its implementation, presents estimated capital and production costs, economic justification and the consultants' conclusions and recommendations. Reference should be made to this report for the many details not included in the following summarized presentation. The proposed zinc reduction plant would use the Sterling furnace electrothermic process for which the New Jersey Zinc Company holds patents in the United States and other countries, and which for use in Burma offers more advantages than does the electrolytic process. To provide for production during repair periods, the proposed plant would use two Sterling furnaces. The plant would treat a mixed feed of ore and concentrates to produce daily 70 short tons of prime western grade slab zinc, or 50,000,000 pounds annually. Lead, silver and pig iron would also be produced as by-products. Ores and concentrates will be available to maintain this rate of production for more than 20 years.

(b) Capital investment and financing. As presently estimated, the project will require an investment equivalent to $7,750,000. This will provide for construction of the zinc plant with all necessary service facilities, coal and char storage and railway and river port facilities, housing accommodation and community facilities for all employees, preparatory work and metallurgical tests necessary for finalizing plans and specifications, and foreign technical assistance and services. Approximately 40% of the capital cost will be local currency and 60% foreign exchange. In the project report all foreign exchange costs have been estimated in United States dollars, but about 85% could be made in sterling, the exception being the cost of foreign engineering and managerial services for which dollar expenditure would be preferable.

Initially, the Government would make a capital contribution of K26,60,532 to provide for certain preparatory work and metallurgical tests essential for confirming or correcting calculated operating costs and profits and finalizing plant designs. This work would require at least one year and the availability of the balance of the capital required would be made contingent upon its satisfactory outcome.

(c) Implementation. It is assumed that the Mineral Resources Development Corporation would be made responsible by the Government of the Union of Burma for securing implementation of the project. Three to four years from the date of government approval and authorization would be required to bring the project to the production stage. In order to secure its execution the Corporation would have to employ foreign technical assistance, engineering and managerial services.

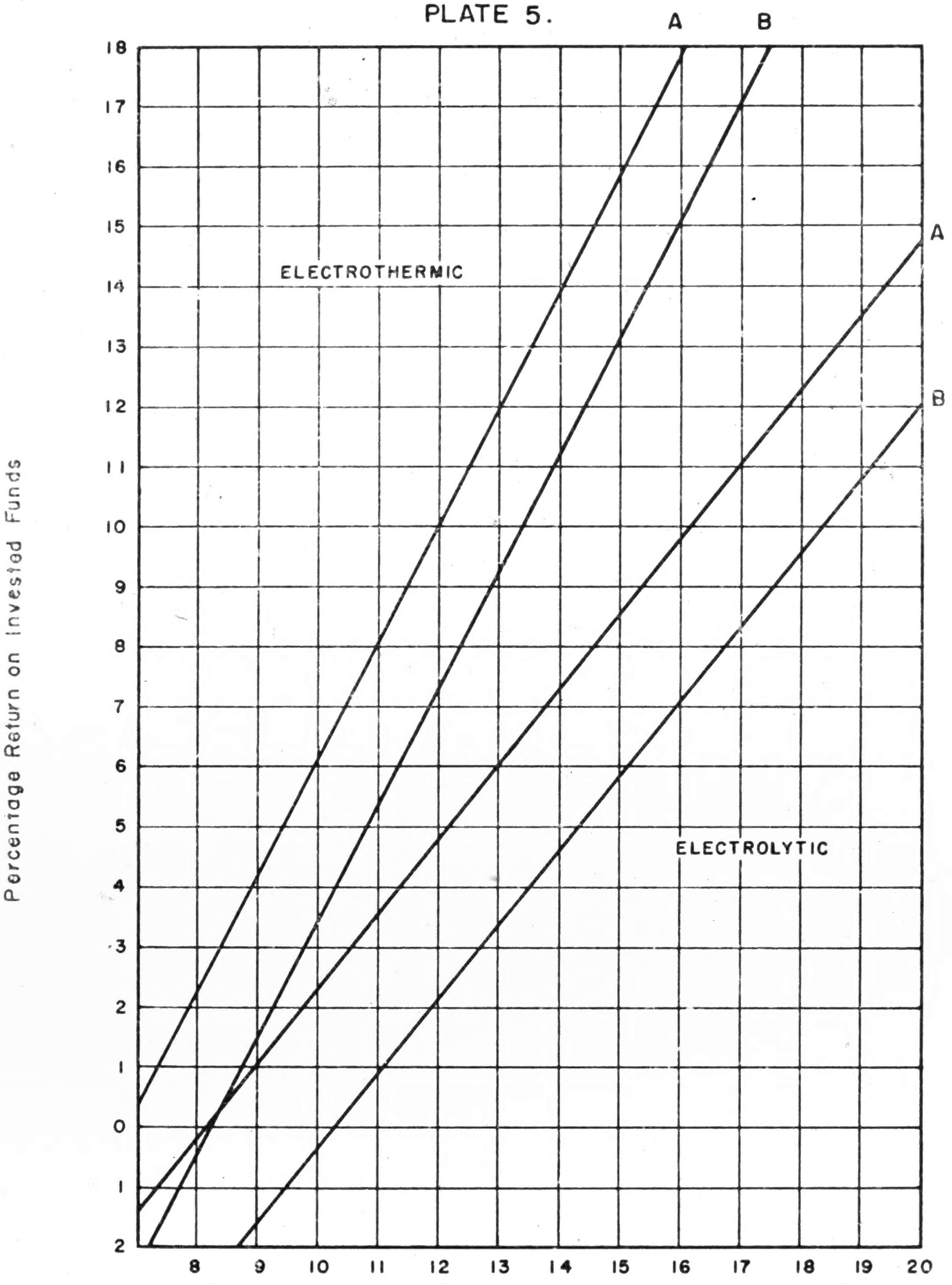
(d) Economic justification. To date the zinc exported from Burma has been contained in concentrates produced by Burma Corporation and, in comparatively insignificant amounts, zinc ores produced from other sources. Generally, realization costs have made export unattractive except when the price of zinc has been comparatively high. The establishment of a zinc reduction plant in Burma would provide producers with an assured local market more favorable than would be obtainable offshore.

Based necessarily on a number of important assumptions set forth later in this report, an evaluation of operating costs and profits shows that the proposed zinc reduction plant could be operated profitably so long as the base price of prime western zinc is ten cents per pound or higher. Final evaluation may confirm a break-even price of eight cents per pound for slab zinc delivered in the European market.

Return of the capital investment is provided for by including a depreciation charge in the total estimated cost per pound of zinc produced and delivered to the European market. The charge is based on a 15-year straight-line depreciation rate with the annual charge distributed against full annual production of 50,000,000 pounds. The return on the invested capital, before income taxes, is estimated at the rate of 6·13% with zinc at 10 cents, 10·0% with 12 cent zinc, 13·87% with 14 cent zinc and 17·81%, with 16 cent zinc. Reference may be made to Table E–14 in the Project report which shows the return after "Capital Return with Interest" charges, instead of by depreciation (also see Plate 5).

The Union of Burma would derive other economic advantages from execution of the project. Increased

PLATE 5.



RETURNS ON INVESTMENT

Showing Percentage Returns on Total Funds Invested in an Electrothermic Zinc Plant and an Electrolytic Zinc Plant :
A, after Return of Capital by Straight-Line Depreciation Charge
B, after Return of Capital With Interest Charge.

PIERCE MANAGEMENT-K.T.A. RANGOON. JULY. 53.

foreign exchange earnings would result, ores otherwise not economically attractive would become exploitable, the discovery and development of new sources of production would be stimulated, and additional employment would be afforded Burmese workers together with opportunity for the development of new technical knowledge and skills.

(e) Recommendations. The calculations and estimates upon which the economic justification of the project are based are themselves necessarily based on certain important assumptions which require confirmation. The availability of Kalewa coal, for example, and of electric power produced from it are two basic factors which are not firm. Two other examples are the bases on which ores and concentrates can be purchased and on which rights for use of the Sterling process, for "know-how" and for furnace tests can be acquired from the New Jersey Zinc Company. These assumptions and others set forth on page 6 of the Project Report should be confirmed or corrected and all calculations and estimates revised accordingly, where necessary, before starting any design engineering.

If capital funds are available for investment under the conditions outlined, it is recommended that the project be approved for financing and execution in the manner which has been proposed. With successful negotiation of the proposed foreign loan—the availability of which would be made contingent upon the preparatory work having satisfactorily confirmed the estimated investment cost, operating results, and return on the investment—authority and the necessary funds would be given to the Mineral Resources Development Corporation for the execution of the preparatory work. Then, if the results of the preparatory work and metallurgical tests demonstrate equal or better economic justification for the project, execution of the construction stage is firmly recommended.

(3) General presentation

(a) Objective. The objective of this project is the establishment at Myingyan of a profitable zinc smelting and refining industry based on fuel and electric power to be afforded by Kalewa coal, zinc concentrates to be supplied by Burma Corporation and zinc ores provided by exploitation of the Lough Keng deposit, hereinafter under reference as the Shwedaung mine.

Attainment of this objective would result, coincidentally, in securing for Burma other objectives in the form of economic and social benefits which are mentioned hereinafter under **(e)** of this section.

(b) Description

(1) *Basic assumptions*

In evaluating at this time the economic justification for a zinc reduction plant in Burma, and in considering to this end the comparative merits of the Sterling electrothermic and electrolytic processes, it has been necessary to make the following more important assumptions:

(*a*) The necessary funds, in the form of equity capital, can be obtained for the construction of a zinc plant of any size which is economically feasible, up to a daily capacity of 100 tons of slab zinc.

(*b*) The Bawdwin lead-zinc ore reserves are adequate to supply to the zinc plant the total requirements of zinc concentrates for a sufficient length of time to justify its erection.

(*c*) The Bawdwin zinc concentrates will be purchased under a long-term contract at a price at the concentrator not in excess of the realization at the concentrator, should these concentrates be sold to offshore smelters.

(*d*) Shwedaung zinc carbonate ores will be purchased under a long-term contract, at the same price, at the zinc plant, per pound of recoverable zinc as the Bawdwin concentrates.

(*e*) The reserves of the Shwedaung mine are adequate to supply to the zinc plant the total requirements of ore for a sufficient number of years to justify its erection.

(*f*) Myingyan on the Irrawaddy River will be assumed to be the plant site, but an alternate site at Monywa on the Chindwin River will be investigated to determine its comparative economic advantages.

(*g*) Adequate power can be obtained at a cost delivered to the zinc plant of not more than 1·0 cents (US currency) per kilowatt-hour, after including depreciation and a satisfactory return on the capital invested in the power plant and distribution system.

(*h*) Mutually satisfactory arrangements can be made by the financial interests with the New Jersey Zinc Company for rights to use the Sterling patents, for "know-how" and for testing Bawdwin concentrates and Shwedaung ore with Kalewa char in the Sterling furnace at Palmerton, New Jersey.

(*i*) Char made from Kalewa coal will prove to be satisfactory for use in the Sterling furnace and can be made available in the required quantities.

(*j*) All zinc is to be sold in Europe even though there is a local and nearby market for about 30,000 tons per annum which should be more economically advantageous.

(*k*) The zinc plant will operate at full capacity throughout the year and will be so located that the waste smelter gases can be discharged into the atmosphere without damage to the surrounding areas.

(2) *Material available for treatment*

(a) The Bawdwin mine near Lashio has been one of the world's richest lead-zinc-silver mines. In the years just prior to World War II, it produced about 66,000 tons of zinc concentrates containing 55% zinc. During the war, the concentrator at Namtu was destroyed and other installations were severely damaged. Production operations have been resumed and progress is being made toward the contemplated primary objective of about 22,000 tons of zinc concentrates per year, from which about 30 tons of slab zinc could be produced daily. This would require the mining of about 8,000 tons of ore per month. The secondary objective would require doubling the underground labor force required for the first, and the addition of ore treatment facilities at an extraction rate of about 25,000 tons of mined ore per month. If realized this would result in the resumption of zinc concentrate production at the rate of about 66,000 tons per year.

The "Survey-Zinc" compiled by the National Security Resources Board of the US Government, March 1951, shows the following estimated reserves:

BAWDWIN MINE

	High Grade	*Low Grade*
Tonnage	3,000,000	24,000,000
Metal content, zinc	12·1%	8·5% cut-off
Metal content, lead	19·5%	7·0% cut-off
Metal content, copper	0·84%	—
Metal content, silver	15·1 ozs./ton	3·0 ozs./ton

Current investigations have not confirmed the existence of such a large tonnage of low-grade ore. On the contrary about 3,500,000 tons of marginal ore averaging about 5·3% zinc and 8·9% lead which comprise extensions of the higher grade ore already mined, can be reliably estimated on the Chinaman and Shan lodes and about 1,000,000 tons of a similar grade might be disclosed by development and exploration work on the Meingtha lode. The location of this known and probable material in the Bawdwin mine, the development necessary to make it available for extraction, the additional capital cost that would be required to provide expanded concentrating plant facilities, and the anticipated future prices of zinc would all be important factors in determining whether this low grade material could be considered as a potential source of supply to the zinc reduction plant.

The investigations of this low-grade ore possibility are reviewed hereinafter in paragraph E–9–c. However, on the basis of the high-grade reserves only, and at the presently contemplated maximum rate of reduction of about 22,000 tons of zinc concentrates per year, there would be sufficient ore to supply the zinc reduction plant with 67·5 short tons of zinc concentrates daily for 27 years.

(b) The Shwedaung mine is located about 38 miles east of Taunggyi in the southern Shan State on what is known as the Lough Keng ore deposit. Here about 550,000 metric tons of zinc carbonate ore, containing 40% zinc as mined, exists above the surface, amenable to very cheap surface mining operations. The development program to determine probable extensions of the ore body below the surface has been recommended, and its execution is presently planned by the Mineral Resources Development Corporation for initiation before the end of this year.

At the rate of extraction necessary to supply the presently estimated zinc plant ore requirements of just over 100 short tons per day, the known ore above the surface will suffice for more than 15 years. To make this ore available, however, the Shwedaung mine would have to be equipped for economical surface mining and motor truck transport of the ore to railhead. For the latter purpose, an access road about 25 miles long would have to be constructed. An estimate of the cost of equipping the mine for production on the basis outlined is given hereinafter in paragraph E–9–d.

(3) *Choice of zinc reduction process*

The proposed zinc reduction plant would use the Sterling furnace electrothermic process for which the New Jersey Zinc Company holds patents in the United States and other countries. The recommendation to use this comparatively new but proved process was made only after a careful comparison with the well known and much used electrolytic process on which the preliminary report project was based.

The electrothermic process is described in the June 1952 issue of the Journal of Metals and in the relevant US patents. Two furnaces using the process are now under construction by the Cerro de Pasco Company in Peru, and other zinc producers are understood to have shown interest in acquiring rights to use the process. While use of the process would necessitate acquisition of patent rights and the required "know-how" from the New Jersey Zinc Company, enough information is available in the technical and patent literature to permit a determination to be made of its economic feasibility for use in Burma, based on general metallurgical experience.

Although the conclusion that the electrothermic process is economically more advantageous than the electrolytic process appears amply justified, for comparative purposes the estimated capital costs, and the estimated operational results and costs of the two processes are presented in the project report under Sections E and F. For ready comparison, reference may be made to Table XXI – 4.

TABLE XXI – 4

COMPARISON OF ESTIMATES

ELECTROLYTIC AND ELECTROTHERMIC ZINC PLANTS

This tabulation compares the preliminary estimates of the operational results and investment returns from an electrolytic zinc plant with those expected from the proposed electrothermic zinc plant.

	Electrolytic	*Electrothermic*
Metallurgical Data		
Concentrates required daily, DST	128	171
Grade of metal intake	46%	45%
Overall recovery	85%	90%
Grade of slab zinc produced	Special High Grade	Prime Western
Short tons of slab zinc daily	50	70
Pounds of zinc per year	36,000,000	50,000,000
Producing Costs, Zinc at 12 cents/lb.		
Concentrates	3·40	3·27
Refining	5·58	4·43
Depreciation on zinc plant	1·48	1·03
Delivery	1·47	1·47
Special high grade premium	1·00	—
Patent costs	—	0·25
Total Costs	10·93	10·45
By-product credits	none	none
Annual Income before Income Taxes		
Base price of Prime Western Zinc—		
10 cents/lb.	$ 187,200	$ 475,000
12 cents/lb.	385,200	775,000
14 cents/lb.	583,200	1,075,000
16 cents/lb.	—	1,380,000
Total Investment Required (Equivalent Dollars)	7,970,000	7,750,000
Return on Investment (after Depreciation but before Income Taxes		
Base price of Prime Western Zinc—		
10 cents/lb.	2·35%	6·13%
12 cents/lb.	4·83%	10·00%
14 cents/lb.	7·32%	13·87%
16 cents/lb.	9·80%	17·81%

Briefly, the electrolytic process can produce either high grade or special high grade zinc, both of which command a price premium over prime western grade. The electrothermic process produces prime western grade zinc, crude lead bullion and pig iron. It can successfully treat ores with a higher iron content than the electrolytic process and it recovers a higher percentage of the zinc content of the material treated. For use in Burma, the comparison favors the electrothermic process.

(4) *Proposed electrothermic zinc plant*

The use of electricity for the production of zinc in an electrothermic zinc process has been tried in nearly every type of electric furnace with varying degrees of success prior to the development of the Sterling furnace by the New Jersey Zinc Company. The process produces prime western grade zinc by liquation of the molten metal condensed from the metal vapors from the electrothermic furnace. If economically feasible, the prime western zinc can be distilled to produced special high grade (99·99% zinc) and by-products under a process also patented by the New Jersey Zinc Company. The absence of cheap natural or producer gas for heating, the high cost of electricity, and the small amount of cadmium in the ores and concentrates, makes the production, in Burma, of special high grade zinc appear unattractive. The calculations on the electrothermic zinc process, are, therefore, based on the production of prime western zinc.

Furnaces require relining and other repairs. It would be undesirable to design a plant around one furnace and have no production during repair periods. Hence, the proposed plant would use two Sterling furnaces. Together they would treat a mixed feed comprised of all of Burma Corporation zinc sulphide concentrate production and whatever tonnage of Shwedaung zinc carbonate ore might be required to produce 70 short tons of prime western slab zinc per 24 hours. Full annual production would thus total say 25,000 tons or 50,000,000 pounds of zinc metal.

When the resumption of Burma Corporation mining and milling operations reaches the level planned, it is understood that 22,000 long tons or 24,640 short tons of zinc concentrates will be produced annually. At this rate 67·5 short tons per day would be available for the zinc plant. For estimating purposes, a 52% Zn grade has been taken and a 92% plant recovery. On the lower grade zinc carbonate ore from Lough Keng, the assumption of a grade of 40% Zn and a recovery of 88% is warranted. Hence, in addition to the 67·5 tons of Burma Corporation zinc concentrates, 103·78 tons of Shwedaung ore would be required daily to provide for the production of 70 short tons of slab zinc. The grade of this mixed feed would be approximately 45% Zn and the average plant recovery 90%. These are the percentages used in estimating operational results, costs and profits.

A plant for the production of sulphuric acid from the waste gases could be constructed later as an addition to the zinc plant should the nearby industrial demand in Burma justify it. Also, the capacity of the zinc production plant could be readily increased by the addition of one more furnace. This would be justified if the rate of production from either Burma Corporation's ore reserves or from the Shwedaung mine were to be increased, or both. The capital cost estimates of this project do not provide for an acid production plant or expansion of zinc production by employing a third furnace.

(5) *Auxiliary installations and facilities*

While the only project facility under reference so far has been the electrothermic zinc plant, the following auxiliary installations and related facilities are also essential.

Provision must be made for coal and char storage, for railway spur connections and for river port facilities. Housing and living quarters must be constructed for all staff and employees. A hospital, school, and community hall and cinema must be provided along with recreational and religious facilities. Electricity, water supply, sanitation, roads and local telephone communications are other essential items.

(c) Implementation. It is assumed that the Mineral Resources Development Corporation would be made responsible for securing implementation of the project. To bring it to the production stage, it is estimated, would require three to four years from the date of GUB project approval and authorization.

One year would be needed in which to accomplish certain metallurgical tests and other preparatory work necessary before plans and specifications can be finalized and construction initiated. These preliminary steps are outlined hereinafter under the headings "Capital investment required" and "Recommendations." Following completion of this stage, two to three years would be required for the construction of the zinc reduction plant and all necessary auxiliary facilities.

In order to secure execution of the necessary preparatory work and the following construction stage, the Corporation will have to employ foreign technical assistance in the form of engineering and managerial services. It will need such assistance, also, during the first years of production operations. As the proficiency of Burmese counterpart technical personnel increases, the need for foreign technical assistance will decrease so that comparatively little should be required after the first three years of operation. Eventually, the need for any should disappear.

(d) Capital investment required. The capital investment required cannot be stated firmly until the plant site at Myingyan has been selected, the furnace tests of ores and concentrates completed and estimates are prepared from general arrangement drawings based on New Jersey Zinc Company "know-how." Notwithstanding this fact, the following estimates are indications of the magnitude of the capital investment required. No estimate of the working capital required is included.

(1) *Zinc plant*

It is estimated that an electrothermic zinc reduction plant designed to produce 70 tons per day of prime western grade slab zinc using two Sterling furnaces and possessing the necessary service facilities would cost, erected at Myingyan, the equivalent of about $5,250,000. Adding ocean freight and inland transportation increases the cost to $5,418,147.

(2) *Rail, river and storage facilities*

Coal and char storage and railway and river port facilities will cost an estimated $181,626.

(3) *Employee housing and community facilities*

The estimated cost of providing suitable housing accommodation for all plant employees, electric service, streets, lighting, water supply, sanitation, community school, cinema, hospital and religious and recreational facilities is $718,713.

(4) *Preparatory work and furnace tests*

Before construction plans and specifications can be finalized, certain metallurgical tests and other preparatory work will have to be accomplished. The preliminary surveying and mapping of plant site possibilities, town-sites, and of locations for rail and river transportation facilities will be necessary.

Furnace test runs will have to be made in the United States by the New Jersey Zinc Company, using Kalewa char with zinc concentrates and zinc ore, for confirming the operational estimates in this Report and for finalizing plant designs and specifications. For this purpose it will be necessary to mine and ship to the United States 5,000 tons of Kalewa coal and 2,500 tons of Lough Keng zinc carbonate ore. The shipment of 2,500 tons of zinc concentrates will be required.

(5) *Technical assistance*

Foreign technical assistance will have to be provided for securing execution of the project as outlined above in (1), (2), (3), and (4). Similarly, it will be required thereafter during the first several years of plant operation. Included in the total capital cost of the project at an estimated cost of $871,400 is provision only for the engineering, supervisory and managerial services required for the preparatory work and construction stage of the project. The cost of the zinc plant design, plans and specifications is included independently in the estimated capital cost of that item, as set forth in (1).

(6) *Total capital cost*

The total capital cost of the project is estimated at the equivalent of $7,750,000 ($4,666,659 plus K1,46,45,869). Table XXI – 5 recapitulates the capital cost items in the preceding paragraphs under headings which show the estimated breakdown of the total into foreign exchange requirements, including ocean freight and local currency requirements.

(e) Economic justification. To date no zinc metal has been produced commercially in Burma. The zinc exported has been contained in sulphide flotation concentrates produced by Burma Corporation and, in comparatively insignificant amounts, in zinc ores produced from other sources. Generally, the cost of rail and ocean freight, handling and storage, offshore smelting and refining charges and all other realization costs have made the export of concentrates economically unattractive except when the price of zinc has been comparatively high. The profitable export of zinc ores has required even higher prices. As one result, there has been and is little incentive for developing new zinc production from known deposits or for discovering new ones. The establishment of a smelter and refinery in Burma would provide producers with additional incentive in the form of an assured local market more favorable than would be obtainable offshore.

A zinc plant at Myingyan must show sufficient savings in treatment and shipping charges, as compared with the corresponding charges for sales to European smelters, to justify the investment, and give a satisfactory return to the mine operators at zinc prices lower than those recent zinc prices at which it became unprofitable for the mine operators to ship.

A preliminary evaluation of the project, based necessarily at this time on important assumptions set forth earlier in this Report, shows that a zinc reduction plant could be operated profitably in Burma so long as the base price of prime western

Table XXI – 5

CAPITAL INVESTMENT REQUIRED—RECAPITULATION ELECTROTHERMIC ZINC PLANT

	Dollars			*Kyats*	
Item Description	*Equipment or Services*	*Ocean Transport*	*Inland Transport*	*Materials*	*Labor**
a. Zinc Plant	3,500,000	147,000	11,00,450	16,62,500	66,50,000
b. Rail, River and Storage Facilities	135,000	5,300	36,300	51,000	1,09,000
c. Housing and Community Facilities	150,000	8,000	23,389	16,70,000	9,70,000
d. *Preparatory Work and Furnace	224,525	—	25,00,959	2,23,260	2,56,748
e. †Technical Assistance	721,359	—	—	7,12,703	—
‡Credit for zinc metal produced from test runs in (3)(d)(4)	(–)224,525	—	(–)3,20,440	—	—
f. Subtotals	4,506,359	160,300	23,40,658	43,19,463	79,85,748
g. Grand Total	4,666,659	—	—	1,46,45,869	—
h. Equivalent dollars	7,750,000	Equivalent Kyats		3,68,12,499	

* The purchase cost of Bawdwin concentrates and costs of procuring Shwedaung ore are included respectively under "Materials" and "Labor." The cost of producing Kalewa char, test expenses, and consultants' fees are included under "Equipment or Services."

† All local currency costs are listed under "Materials."

‡ $419,800 credit from sale of 4,198,000 pounds prime western zinc at 10 cents per pound, less 15% on dollar equivalent of total of *d.* above, is $291,985. This is equivalent to a credit of $224,525 plus K3,20,435, making the total capital cost of *d.* K26,60,532 only.

zinc is ten cents per pound or higher. Final evaluation may confirm a break-even price of eight cents per pound for slab zinc delivered in the European market.

Average US prices for prime western from 1902 to 1937 show 2·876 cents per pound in 1932 as the outstandingly lowest price. During the war period, from November 1941 to September 1946, the price was controlled at 8·250 cents per pound. Prices have remained higher since 1946; from October 1951 till May 1952 the US price was 19·5 cents. At the time the Myingyan zinc project report under reference was written, the London quotation was 9·81 cents (March 28, 1953). While no prediction of the expected long-term future price can be satisfactorily supported, there are reasons for expecting that future prices will not remain much below eight cents for any considerable period, even if they should, at times, decline to that level. World consumption and demand for most metals is more likely to increase in the future than to decrease. At the same time, the decreased purchasing power of world currencies reduces the likelihood of any full return to prewar wage and price levels.

To recapitulate, for easier correlation with the following paragraphs, the total cost of the zinc reduction plant project, set forth in the preceding table, is estimated at the equivalent of $7,750,000 or K3,68,12,499. Included in this total are the costs of all necessary preparatory work, metallurgical tests, auxiliary and dependent facilities, and all necessary employee housing and community facilities. Working capital has not been included. At full capacity the plant would produce 70 short tons per day of prime western grade slab zinc or 50,000,000 pounds annually.

For the purpose of considering financial results two calculations have been made. The first assumes that all funds which might be invested in the project are equity capital. The return on this capital is provided by using a 15-year straight-line depreciation rate. Thus, the annual depreciation charge would be $516,667. At full capacity of 50,000,000 pounds per year, this depreciation charge would be 1·03 cents per pound. It has been included in the total estimated cost per pound of zinc produced and delivered in the European market. The return on the invested capital, before income taxes, is, therefore, the profit per pound of zinc produced and delivered to market multiplied by the annual production of 50,000,000 pounds. The annual return on the total capital investment is shown for various zinc prices in Table XXI – 6 These results are shown graphically on Plate 5.

The second calculation of financial return is based on "Capital Return with Interest" charges, instead of straight-line depreciation. The results of this method of capital return are shown in Table XXI – 7 and likewise on Plate 5.

TABLE XXI – 6

RETURNS ON CAPITAL INVESTMENT

(After "Capital Return by Depreciation Charge)

Base Price Prime Western cents lb.	*Income before Income Taxes*		*Return on Total Investment of $7,750,000*
	cents lb.	*Annual*	
		(Dollars)	*(per cent)*
10	0·95	475,000	6·13
12	1·55	775,000	10·00
14	2·15	1,075,000	13·87
16	2·76	1,380,000	17·81

TABLE XXI – 7

RETURNS ON CAPITAL INVESTMENT

(After "Capital Return With Interest" Charge)

Base Price of Prime Western	*Income before Income Taxes*		*Return on Investment Plant cost $7,750,000*
	cents lb.	*Annual*	
		(Dollars)	*(per cent)*
10	0·53	265,000	3·42
12	1·13	565,000	7·29
14	1·73	865,000	11·16
16	2·34	1,170,000	15·10

The preceding tabulations apply to any distribution between Burma Corporation concentrates and Shwedaung ore. The reduction process used also produces as by-products crude lead bullion containing some silver, and pig iron containing a small amount of copper. The crude lead can be returned to the lead smelter and refinery at Namtu for the production of refined lead and silver. No credit for these by-products has been taken at this time in estimating cost and investment returns.

In addition to the return on the invested capital, the Union of Burma itself would derive economic advantages as follows:—

(1) More foreign exchange earnings would result from the export of refined zinc than from the equivalent metal exported in the form of concentrates and ores.

(2) The exploitations of the Lough Keng zinc carbonate ore deposit, which without a reduction plant would not be economically attractive, would become possible and thus enable the production and export from Burma of increased tonnages of zinc. Exploration for probable extensions of this deposit would become more attractive.

(3) Burma Corporation might be able to increase its ore reserves by lowering its cutoff grade or limit of payability and, consequently, be able to consider expansion of its presently planned production rate.

(4) The discovery and development of new sources of lead and zinc production would be generally stimulated.

(5) Establishment of the industry would provide additional employment for Burmese workers and would afford opportunity for the productive development of new technical knowledge and skills.

(f) Proposed method of financing. The total capital investment required is estimated at $4,666,659 and K1,46,45,869 the sum being equivalent of $7,750,000. Assuming that equity risk capital will not, in fact, be readily found, it is proposed that the Government of the Union of Burma:

(1) Provide initially K26,60,532 (equivalent to $560,112), the amount required for execution of the preparatory work and metallurgical tests summarized in paragraph (3)(d)(4);

(2) Negotiate a loan of $4,500,000 to provide for 96·4% of the foreign exchange required for the execution of the project, the availablity of the loan to be contingent upon the successful conclusion of the execution of (1), the resultant confirmation of presently estimated operating profits and the satisfactory finalization of plant design and specifications;

(3) Undertake to provide, concurrently with the availability of the loan negotiated under (2), the balance of the estimated capital requirements of foreign exchange and local currency, namely $166,659 and K1,19,85,337;

(4) Designate the Mineral Resources Development Corporation as the agency responsible for securing:

(*a*) Implementation and execution of (1) above;

(*b*) Execution of the construction stage of the project following the successful conclusion of (1); and

(*c*) Satisfactory production operations thereafter.

(g) Recommendations. The calculations and estimates upon which the economic justification of the project are based are themselves necessarily based, in turn, on certain important assumptions which require confirmation. The availability of Kalewa coal, for example, and of electric power produced from it are two basic factors which are not firm. Two other examples are the bases on which ores and concentrates can be purchased and on which rights for use of the Sterling process, for "know-how" and for furnace tests can be acquired from the New Jersey Zinc Company. These assumptions, set forth in paragraph (3)(b), should be confirmed or corrected and all calculations and estimates revised accordingly, where necessary, before starting any design engineering.

If capital funds are available for investment under the conditions as outlined, it is recommended that the project be approved for financing and execution in the manner which has been proposed. With successful negotiation of the proposed foreign loan—the availability of which would be made contingent upon the preparatory work having satisfactorily confirmed the estimated investment cost, operating results and return on the investment—authority and the necessary funds would be given to the Mineral Resources Development Corporation for the execution of the preparatory work. Then, if the results of the preparatory work and metallurgical tests demonstrate equal or better economic justification for the project, execution of the construction stage is firmly recommended.

In anticipation of satisfactory confirmation of the estimated investment cost, operating results and return on the investment and, contingent thereon, approval for execution of the construction stage of the project, it is recommended that the Mineral Resources Development Corporation proceed towards implementation and execution of the project as follows:

(1) Ascertain the grades and quantities of zinc required by India annually and negotiate a contingent trade agreement with that country for the purchase of as much of Burma's potential zinc production as possible over a long period of years at a price competitive with India's other sources of zinc supply.

(2) Determine what possibilities exist for expanding the presently contemplated rate of production of concentrates from the Bawdwin mine by the exploitation of low grade material below the cutoff grade used in calculating ore reserves, as presently declared.

(3) Negotiate a contingent long term agreement with Burma Corporation for the purchase of Bawdwin concentrates, delivered at Namyao.

(4) Secure exploration of the Lough Keng ore deposit for extensions of the known ore body, formulate plans for extracting ore from the Shwedaung mine at a rate of not less than 40,000 tons per year, negotiate a contingent agreement providing for the exploitation of the deposit at the foregoing rate, providing therein the financing necessary for the construction of an access road and the equipment of the mine for production.

(5) Negotiate a contingent agreement with the New Jersey Zinc Company for the use of their electrothermic process; their testing of the process at Palmerton, New Jersey with Bawdwin concentrates, Shwedaung ore and Kalewa char; and for the design and specifications for the proposed zinc plant at Myingyan.

(6) Obtain a 5,000-ton sample of Kalewa coal and store it at Kalewa on the Chindwin River ready for shipment to the USA for the production of char to be used in testing and reducing Bawdwin zinc concentrates and Shwedaung ore.

(7) Obtain a 2,500-ton sample of Shwedaung ore and stockpile it at railhead at Shwenyaung ready for shipment to the USA.

(8) Arrange for obtaining a 2,500-ton sample of Bawdwin zinc concentrates for shipment to the USA.

(9) Investigate alternative plant sites at Myingyan, select the best plant location, and secure an adequate topographic survey and map of the construction area (aerial photographs for topographic mapping purposes have already been made of the Myingyan area and general topographic maps should be shortly available for detailed survey work).

(10) Employ a competent mining and metallurgical engineer supported by the services of a consulting mining engineering firm to assist the Corporation in securing implementation and execution of the foregoing recommendations.

Assuming satisfactory results from the Kalewa project, the New Jersey Zinc Company tests should proceed as soon as possible. The satisfactory completion of these tests and the steps outlined above will provide a sufficient basis for proceeding with the execution of the project by utilization of the contingent foreign loan proposed under (f).

c. Bawdwin Low-grade Ore Reserves

In the "Survey-Zinc" published by the National Security Resources Board of the US Government in March 1951, the low-grade ore reserves of the Bawdwin mine were estimated to contain 24,000,000 tons averaging 8·5% Zn, 7·0% Pb and 3·0 ozs. Ag per ton. These figures were quoted on page 8 of the Myingyan zinc project report dated March 31, 1953, and cited in the preceding section under this heading. However, a special investigation has been made and separate report submitted on the "Investigation of Low-grade Resources in the Bawdwin Mine." As a result and from data based on calculations made in 1928, the quantities shown in the following Table XXI – 8 were made available.

TABLE XXI – 8

BAWDWIN LOW GRADE ORE, JULY 1928

Location	*Tons*	*Ag ozs/ton*	*Per cent*		
			Pb	*Zn*	*Cu*
Chinaman Lode					
Proved	2,857,713	6·4	8·9	5·4	0·13
Probable	252,375	4·9	10·4	5·9	0·11
Total	3,110,088	6·3	9·1	5·4	0·13
Shan Lode					
Proved	691,727	5·2	8·5	4·9	0·10
Probable	68,457	3·8	8·0	4·2	0·05
Total	760,202	5·0	8·5	4·8	0·10
Grand Total					
Proved and Probable	3,870,290	6·0	8·9	5·3	0·12
Subsequent Extraction (values not determinable)	101,401				
Estimated Reserve	3,768,889	6·0	8·9	5·3	0·12

These figures show proved and probable ore of this category totalling 3,870,290 tons and subsequent extraction estimated at 101,401 tons. This is believed to have resulted from normal mining extraction procedure where some low-grade ore is taken rather than to terminate the stopping at possibly ill-defined boundaries of adjoining high-grade ore.

During the war, an additional 200,000 tons were extracted by the Japanese, and certain tonnages were transferred into the "high-grade" category. The total low-grade ore reserve is therefore estimated at 3,500,000 tons with the average content posted in the foregoing table. Were an estimate to be made of equivalent low-grade ore in the Meingtha lode, it is conceivable that this total might possibly be increased by an additional 1,000,000 tons. The following are further observations:

(1) The low-grade ore estimate refers to definite locations in the mine which can be found again without difficulty. Access to some of the locations might require moderate recovery and rehabilitation of the original development workings.

(2) Practically all of the low-grade ore occurs in the foot walls of two of the main high-grade lodes. Only a few very thin bands of ore have been found on the hanging wall side. Enough development work and sampling has been done to establish this as the definite pattern of low-grade ore occurrence.

(3) Comparing more recent work with the 1928 low-grade estimate, it is apparent that certain lenses and stringers can frequently be picked up in the low-grade sections and mined as high-grade ore. In several instances this was done by the Japanese during their occupation.

(4) There is nothing to preclude the possibility of a similar development of low-grade ore in the Meingtha lode. In the Shan and Chinaman lodes it appears that the amount of low-grade ore is roughly proportional to the amount of high-grade ore.

The extent to which this low-grade ore may be economically important to the future operations of Burma Corporation and the Myingyan zinc refinery has not been determined. It depends on many factors which remain subject to further study, investigation and evaluation in the light of anticipated future operating conditions and metal prices. Because of the considerable value of the metallic content of the ore compared with similar ores successfully exploited elsewhere in the world, the consultants believe its exploitation potentialities should be determined at an early date.

d. Development of the Lough Keng Ore Deposit

The Lough Keng zinc carbonate ore deposit has been mentioned previously in this chapter as one of the two sources of zinciferous material for the Myingyan zinc refinery. Until Burma Corporation can supply a greater tonnage of zinc sulphide concentrates than the 22,000 long tons per year presently contemplated, it is planned to supply the zinc smelter with ore from the Lough Keng deposit containing approximately half of the smelter's total zinc metal output.

To this end, plans have been made for developing and equipping the Shwedaung mine for a daily ore production of 155 short tons, or approximately 3,300 short tons per month. Visible, already measured, surface ore in the deposit amounts to approximately 550,000 metric tons or 607,000 short tons which, at the planned rate of depletion, provides positive reserves for approximately 15 years. The exploratory program recommended to Government should disclose additional carbonate ore below the surface and possibly sulphide ore at greater depth.

The ore deposit, situated in the Shan State at Lough Keng some 30 miles south of Mong Pawn, is not conveniently situated in relation to Myingyan nor to established transportation routes thereto. A major item in the estimated cost of developing this deposit for exploitation is the construction of an approximately 25-mile access road from the town of Mong Pawn to the deposit area near Lough Keng. Another major capital expenditure will be necessary to provide a fleet of trucks to transport the ore from the mine to railhead at Shwenyaung. The distance from Lough Keng to Shwenyaung via Mong Pawn will be about 75 miles, and the cost of haulage will be a large item in total operating costs.

In addition to its inconvenient situation relative to the transportation of ore and supplies, the deposit is also disadvantageously situated in relation to power, water, and labor supplies. Until hydroelectric power is available in this general area, power will have to be supplied by diesel electric generators. Fortunately, power requirements will be very moderate. Owing to the physical and topographic features of the deposit, it will be exploited entirely by open-cut or quarry methods, and ore transportation from the mine to the crushing plant and truck loading bins will be by hand-trammed cars running on light rail. The major power demand, therefore, will be only for compressors, the crushing plant and water supply. It is estimated that the total demand will be met by two diesel generators totaling 350 h.p., required to run simultaneously only during parts of each operating shift. Water required for the mine operation and the camp, estimated at 25,000 gallons per day, will be supplied through a pipeline from the Nam Pawn river approximately 3,200 ft. below the mine. Three 20 h.p triplex pump units, one on the river and the other two at stations approximately 1,000 and 2,000 ft. higher, will deliver into storage tanks in the mine area.

The Lough Keng area is sparsely populated and provision will have to be made for the construction and maintenance of a mining camp complete with appropriate utilities, a school, a hospital or dispensary, and recreational facilities. The capital expenditures required to produce 155 tons of ore per day from the Lough Keng deposit are estimated at $1,100,000. The cost of producing and delivering a ton of Lough Keng ore to rail head at Shwenyaung is estimated at K50.46 per long ton.

The estimates may be summarized as follows:

TABLE XXI – 9

ESTIMATED CAPITAL COSTS

	Total Cost		Equivalent K [illegible]
	$	plus K	
Preliminary Surveys and Engineering	1,150	12,900	[illegible]
Access Road, Mong Pawn to Mine	2,500	22,27,950	[illegible]
Surface Plant (Mine and Shwenyaung, including power plant and all machinery and equipment).	13,810	7,49,950	[illegible]
Heavy Duty Trucks for ore transport and other automotive equipment	200	15,07,500	[illegible]
Water Supply	900	5,54,950	[illegible]
Total Capital Cost	18,560	50,53,250	[illegible]

TABLE XXI – 10

ESTIMATED OPERATING COSTS, PER SHORT TON F.O.R. RAILWAY WAGONS AT MYINGYAN

	Labor, including Supervision and Engineering	*Supplies*	*Total*
	K	K	K
Mining	3·943	11·619	15·562
Ore Transport, Mine to Shwenyaung	3·325	6·833	10·158
Railway Freight, Shwenyaung to Myingyan	—	—	13·385
Depreciation	—	—	8·550
General Overheads	2·705	0·103	2·808
Total Operating Cost	9·973	18·555	50·463

Estimates of results of operation of Lough Keng mine and smelter with zinc at ten cents a pound, show a profit of approximately K32 per ton of ore on the part of the smelter, and a break-even basis for the mine. When the price of zinc drops to nine cents, the composite results of both mine and smelter will show a loss of about K2·0 per ton of ore, or practically a break-even basis.

It will be noted that no provision has been made for the cost of developing the deposit. The reason for this is that, with a positive ore reserve above the surface adequate for a 15-year operation, no urgency exists for immediately establishing additional reserves. After production has begun and is well underway, the subsurface exploration for extensions of the surface ore which has already been recommended to the Mineral Resources Development Corporation and the execution of which is being initiated will have provided guidance for future development work. Additional guidance will also be provided to a considerable extent by the observed behavior and characteristics of the ore deposits in the bottom of the open cuts. Thus any extensive underground exploration and development can be much more satisfactorily planned and executed at a later date and at less cost.

It is assumed that the Mineral Resources Development Corporation will arrange and implement the financing of the program, and that it will be wholly responsible for securing completion of the program at such time that adequate and continuous ore deliveries will be made to the Myingyan plant site when that plant is ready to operate. The execution of the Lough Keng project must be coordinated with the construction of a zinc smelter in Burma. No expenditure should be made at Lough Keng, other than those recommended to prove up the deposit until there is a firm determination of the Myingyan zinc project.

e. Antimony Project

The Antimony project presented in the Preliminary Report had a "first" and an "ultimate" objective. The first was the annual export of approximately 1,260 tons of refined antimony and 3,600 tons of 50% ore. The ultimate objective was the export, in the form of refined metal, of all the antimony Burma might produce.

Achievement of the first objective was planned in two stages. The first stage was to be the successful completion of four separate but related programs: the collection at the site of a central oxidation and reduction plant of 4,000 tons of 20% Sb ore purchased from various mines; the purchase, also from various mines, of shipping-grade ore for export; the selection and development of a "demonstration" mine to produce not less than 6 tons per day of 20% Sb ore, and at the same time 2·4 tons per day of 50% Sb ore; and the construction of a central oxidation and reduction plant as soon as the reasonably certain availablity of 4,000 tons of 20% Sb ore was assured.

The second stage, planned to begin on the completion of the first stage, and expected to be progressive over about eight years, was to consist of selecting the five most promising mines, in addition to the "demonstration" mine, for the development at each of production at least equivalent to that of the "demonstration" mine. An oxidation plant at each of the six mines was programmed, and appropriate progressive increases in the reduction capacity of the central plant that meanwhile would have been purchasing and treating odd lots of ore and ore products from small independent producers. As projected, the successful completion of the second stage would constitute the beginning of achievement of the ultimate objective of funneling all Burmese antimony ores and oxide-plant products into the central plant for conversion into export metal.

In the Preliminary Report, based on estimated capital costs for the two stages of the first objective of approximately K60,00,000 estimated production costs and the then current London quotations for antimony metal, an annual operating profit of K61,74,000 is estimated at the end of the second stage of the first objective, and it is implied that at this price the continuing annual profits would be of the same order.

The development of the project subsequent to the submittal of the Preliminary Report has been seriously impeded. Examination and appraisal of some 20 known antimony deposits proved impossible in all but a few cases because of adverse security conditions. Further, two of the reputedly most promising deposits in the Shan State were examined. One of these, the Mong Sang deposit warrants a vigorous exploration and development program which has been outlined in a separate report and submitted to Government with action recommendations. The other, Lebyin, although optimistically reported in the Preliminary Report, on re-examination did not disclose potentialities justifying exploration work designed to develop the deposit into a "demonstration mine."

The several other antimony deposits and showings examined in the Shan States did not exhibit encouraging geological features, and continued exploration and development could not be recommended. No additional information could be obtained regarding the known and favorably reported antimony occurrences in the Tenasserim Division due to the aforementioned adverse security conditions.

However, despite the inaccessibility of most of the antimony deposits for field examination by the consultants, certain important concepts and assumptions on which the development of the project was formulated were studied and brought more up-to-date by investigations conducted in the United States of the pyrometallurgical treatment of what are believed to be representative samples of Burmese antimony ores, and free world markets for antimony ores as a basis for projecting foreign exchange earnings from the export sale of Burmese antimony ore production anticipated in 1960.

The results of these investigations, conducted by Dr. C. Y. Wang, Consulting Metallurgical Engineer, New York, are contained in a report submitted to the Government in December 1952 entitled "Report on the Proposed Antimony Smelting in Burma."

The seven principal recommendations with which his report concludes may be summarized as follows: that there be thorough geological examination and sampling of all important Burmese antimony mines and prospects; that the initial unit for treating 20% antimony ore have a daily metal output capacity of only one ton; that investigations and experiments be conducted to determine the comparative economic advantages of exporting shipping grade antimony ore (approximately 50% Sb) or treating it in Burma to recover and export the metal; that mechanization of plant installations should not be overdone in the initial stages of developing a smelting industry; that further study of concentration methods for low-grade ores be undertaken; that a study be made to determine the most efficient roasting technique for fine-sized antimony concentrates; and that when a permanent central reduction plant is envisaged, a study be made of methods of recovering the sulphur evolved in the pyrometallurgical treatment of antimony ores and concentrates.

The report gives much space to descriptions and diagrams of various standard practice procedures and equipments, so presented that accurate estimates of capital requirements can easily be calculated by substituting the cost of Burmese materials, transportation, labor and other costs.

For a discussion of world markets for antimony ores and metal and their relationship to prices, consumption and demand, reference may be made to the memorandum submitted by A. J. Creshkoff of Robert R. Nathan Associated Inc., and similar pertinent data from other sources, all of which are being transmitted separately to Government.

In considering the contribution which development of the antimony project can make to the economy of Burma and the justification therefor, an appraisal of future prices in world consuming areas is critical. When the Preliminary Report was compiled the price of antimony was approaching its all-time high which was attained in December 1951. China reputedly has more than half of the world's resources of antimony ore. Prior to 1932 it was the lowest cost producer, and provided about two-thirds of the total world supply. Following her comparatively recent disappearance from world trade in antimony, and her domination of the market, it appeared that Burma could avail herself of an exceptional opportunity to develop a well-organized modern antimony industry which in the future would be able to compete in the world market with China with an advantage or at least on a basis of equality. Meanwhile South Africa has been entering the market as a low cost producer on an increasingly important scale.

Despite the lower prices that have prevailed since the project was first recommended (52 cents per pound in January 1952), and which have remained fairly constant around 30 cents per pound since November 1952 following their steady drop from January 1952 levels, considerable weight must be given to the prediction of mineral economists that consumption between 1950 and 1975 will increase by 92% and that the free world output would keep pace with this demand.

In the contract period subsequent to the submittal of the Preliminary Report, circumstances have not been sufficiently favorable to justify recommending early implementation of the project as outlined in that report. However, in view of the wide price fluctuations to which antimony has been subject in the past, it is very possible that at some time in the future the operation of a properly developed antimony smelting industry can contribute very importantly to the Burmese economy.

It is therefore recommended: (1) that the exploration and prospecting of the Mong Sang deposit, as outlined and recommended in the report of the examining engineer, be given modest priority in the development programs to be undertaken by the Mineral Resources Development Corporation; (2) that the examination and appraisal of the antimony deposits and prospects in the Tenasserim Division, which have remained inaccessible during the contract period, be effected as soon as security conditions permit and when technical personnel are available to the Corporation, or when the Mineral Resources Survey can operate in that area; (3) that wherever and whenever possible instructions be given to antimony mine owners and operators by personnel of the Mineral Resources Development Corporation and the Mine Department, particularly in the operation of the simple Chinese process of intermittent liquation of crude antimony; and (4) that the antimony project, as outlined in the Preliminary Report, be held in abeyance until such time in the future as adequate ore supplies can be assured and its development presents increased economic advantages.

F. CONCLUSIONS AND RECOMMENDATIONS

The orderly and effective development of Burma's mineral resources is essential to the future social and economic welfare of the country. Important progress towards this end has been made during the last 18 months. The Mineral Resources Development Corporation has been established and is taking steps to initiate several of the measures which have so far been recommended. Specific mineral industry development projects which have been proposed are receiving serious consideration with a view to securing their early implementation. It is noteworthy that so much has been accomplished in this relatively short time in the face of such obviously adverse security conditions.

However, accomplishments to date, important as they are, cannot but emphasize the magnitude of the responsibilities which remain for initiation and execution. In the following paragraphs, the recommendation for future action are recapitulated briefly, emphasis placed on certain correlation, and priorities for implementation assessed.

1. In an integrated industrial program for Burma, the basic importance of developing domestic supply of solid fuel cannot be overemphasized. The development of production from the Kalewa coalfield will afford this. Execution of the Kalewa project, as proposed in the report thereon, justifies highest priority so far as industrial development projects are concerned.

As the immediate market for most of the Kalewa production depends upon the production of a briquette suitable for transport and storage during the monsoon season, the implementation of the Kalewa project on the scale recommended must depend upon the further research work being done under GUB Project 60 in briquetting the Kalewa coal, as well as the results of the diamond drilling program now under way. In the event that Kalewa coal cannot be made into a briquette stable under monsoon weather, then consideration must be given to the economics of protected transport and storage. If such storage is not feasible, the Kalewa project must be revised to conform to the needs for pulverized fuel, for power generation, and for the requirements of the Myingyan zinc project. Execution of the Kalewa project, on a basis yet to be determined, justifies the highest priority.

2. Implementation of the Myingyan zinc project is economically justified providing Kalewa coal is made available. In this case, it should be assessed second priority among mineral industry development projects.

3. If the Myingyan zinc project is undertaken, development of the Lough Keng zinc carbonate ore deposit for the production of 40,000 tons of ore annually must proceed concurrently. Without the zinc refinery, or unless the underground exploration program already recommended and initiated discloses very large additional tonnage of ore, the development of the Lough Keng deposit is not economically justifiable. In the latter event, the deposit might prove large enough to justify the establishment of its own zinc refinery and a hydroelectric power installation on the Nam Teng River.

4. The possibility of exploiting profitably the low-grade material occurring on the boundaries of the high-grade orebodies at Bawdwin should be determined as soon as possible. With the establishment of a zinc refinery at Myingyan particularly, and the availability of an indigenous supply of metallurgical briquettes (equivalent to coke), probabilities of profitable exploitation are appreciably enhanced.

5. The antimony deposits at Mong Sang should be further prospected and explored to determine their potentialities and whether they can be made to serve appropriately as the "demonstration mine" envisaged in the Antimony project. As soon as the antimony

deposits in the Amherst and Thaton districts of the Tenasserim Division become accessible, they should be examined and their potential value appraised. Until these steps have been taken, and until the availability of adequate supplies of ores can be reasonably well assured, it is recommended that implementation of the Antimony project be deferred, with the following exception. If exploration should prove large deposits of 4% antimony ore that can be mined cheaply by open cut or underground methods, studies should be made as to the economics of mining and concentrating this ore to supply a high grade concentrate to a reduction plant.

6. It has been recommended that the Mineral Resources Development Corporation be made responsible for securing implementation and execution of the aforementioned mineral industry developments. Additionally it is believed that the Corporation should be made responsible for conducting the continuing program of exploration and discovery recommended in the Mineral Resources Survey project proposal, and that initially, in order to operate to best advantage, it should establish no less than two regional offices.

It was recommended in the Preliminary Report that the Corporation, although government-owned, should be "relatively autonomous," and that it should operate "as a private enterprise without the limitation of civil services, and especially, free from the red tape and lethargy which so often characterizes government enterprises." Most importantly, it was recommended that the executive head of the Corporation should possess some technical knowledge and wide business experience. Unless these recommendations are implemented achievement of the Corporation's objectives will be greatly prejudiced.

On a par with these basically important requirements for successful operation is the necessity for employing at the earliest date competent foreign managerial and technical services and personnel sufficient to serve all of the Corporation's needs until such time as trained and experienced Burmese replacements become available. As recommended first in the Preliminary Report and reiterated now, this step is essential whether the Corporation obtains such personnel by engaging the services of a mine management and consultant firm—which is believed able—or whether, alternatively, it engages individuals to render the various services needed.

7. The functions and responsibilities of the Mines Department should be broadened and its staff augmented in accordance with the administrative and organizational staffing plan previously outlined. Similarly, as soon as trained national personnel become available, the staff and activities of the Geological Department should be expanded.

In order to avoid duplication of personnel and effort, the work of both departments should be correlated closely with that of the Exploration Division of the Corporation and the Mineral Resources Survey for the conduct of which it would be responsible. Payment of appreciably higher salaries to technically educated and trained Burmese personnel is essential if the country's nationals are to be encouraged to undertake such professional careers in adequate number.

8. The revision of mining laws and regulations and mineral industry taxation along the lines recommended will greatly facilitate maximum development of mineral resources and encourage the participation of private enterprise therein. In Burma, where the potential is so great and so underdeveloped, maximum economic development of her mineral resources cannot be achieved during any short period of years unless private enterprise is not only afforded fair opportunity to participate but actively encouraged to do so by the extension of adequate guarantees

CHAPTER XXII

MANUFACTURING

A. REVIEW OF EXISTING NATIONAL INDUSTRY

1. PRESENT NATIONAL INDUSTRIAL PLANT

Burma's national industrial plant has never developed beyond an elementary stage. Existing industry comprises principally the finishing or conversion of agricultural products. The limited variety of the commodities manufactured and their low total value, the relatively limited amount of capital invested, the small number of people employed in industry, and the large imports of basic commodities evidence this lack of development.

No complete list exists covering the extent or variety of the existing industries of Burma or of their current production. The Labor Directorate (*Burma Labor Gazette*, September 1951) lists 882 rice mills, 110 sesamum and groundnut oil extraction plants, 80 flour mills, 3 sugar extraction and refining plants, 16 beverage plants, 194 saw mills, 67 cotton ginning and spinning mills, 3 match factories, 1 cement plant, and some tobacco, rope, printing, and engineering plants. There are also a starch plant, a soap factory, two small glassware plants, one or more rubber products plants, and other small industries.

About 43,000 permanent employees out of a labor force in excess of 8,000,000 are said to be employed in the manufacturing plants reporting to the Labor Directorate. Even if the total number of industrial employees exceeded the above by 200 or 300%, the labor employed in manufacturing industry would still be small.

2. CAPACITY IN RELATION TO CURRENT CONSUMPTION

Some of the industrial plants are so small that they may be classed as cottage industries. Many are obsolete, inefficient, and high cost producers. Practically none supply the entire requirements of Burma for any single commodity. Inadequate facilities exist for supplying many of the common basic commodities such as clay roofing tile, clay floor tile, lime, asbestos cement roofing and siding and sheets, steel products, fertilizers, pharmaceuticals, paints and varnishes, paper, jute bags, insecticides, chemicals, biologicals, wall board, plywood, naval stores, glass products, canned food products, soya milk, frozen food products, and many others.

Only in rice milling, saw milling and a few other industries is the existing capacity able to supply the entire needs of the nation. Portland cement manufacturing capacity is now below current demands.

3. CAPACITY IN RELATION TO PROJECTED CONSUMPTION

As in general the existing national industries are unable to meet current demands for their products, it is evident that they are completely unable to supply any increase in demand. The normal increase in population alone will provide a growing market for all commodities consumed or used in Burma. The execution of the Economic and Industrial Development Program will create tremendous demands for all basic construction materials. The additional employment and payrolls created by the construction, operation, and maintenance of the new projects, will develop an additional demand for many commodities that cannot be met by the existing national industrial plant, yet in many cases these demands can be met economically by domestic production.

To remedy this situation definite recommendations are made in Section D of this chapter.

B. A SURVEY OF INDUSTRIAL POSSIBILITIES FOR BURMA

An exhaustive inventory has been made of all of the known material resources of the Union of Burma, and of the products that are used in commercial quantities in this country, or that could be manufactured in Burma. In addition, careful market surveys were made covering the past and present consumption of all important commodities, and the future requirements were estimated. From this three-way check, a comprehensive list was made of industrial projects for investigation.

1. INDUSTRIAL USES OF THE PRINCIPAL RAW MATERIALS OF BURMA

In preparing the accompanying survey, there has been taken into account all that could be learned of the availability, location and physical properties of materials discussed. The compilation indicates the major industrial uses of each of these materials.

The existence in Burma does not, of course, mean that such resources can support any or all of the industrial possibilities indicated. The quantity available may not be sufficient for commercial extraction. The quality may be poor. The location may be such that extraction is too costly. Other associated raw materials, necessary to turn out a given industrial product, may not be available. The manufacturing process may be too complex, or it may depend for its efficiency on the services of other industries which cannot be developed in Burma. Cheap transportation or power or other factors of efficient production may not be available where needed. Burma may be too far from the world market. Only combined economic and engineering analysis in each case can give the answer as to whether industrial exploitation would be practical.

Any list of raw materials available in Burma is subject to change. New mineral deposits may be discovered. New agricultural or forest crops may be introduced. A material now existing may be found to have been omitted. Moreover, the industrial significance of any given raw material may change. New impregnation techniques may convert so-called nondurable hardwoods into durables. Experimentation may develop new jute-based fabrics suitable for clothing. Increase in the level of income in Burma may create a future market where none is now immediately forseeable. It is important, therefore, to consider the industrial possibilities of Burma's raw materials, not as static and final, but as something always emerging and developing.

TABLE XXII – 1

INDUSTRIAL USES OF THE PRINCIPAL RAW MATERIALS OF BURMA

Agricultural Raw Materials	*Possible Manufactured Products*
Bamboo sprouts	Canned sprouts
Bananas (see plantains)	
Barley	Pressed and pearled barley; bran; beer; flour.
Beans, not elsewhere classified	Dried beans; canned beans; confections and cakes.
Bees	Honey; wax.
Betel nuts	Possibly medicines or manufactured chewing "gum."
Cattle	Packaged meat; milk (boiled, pasteurized, evaporated, condensed, dried); cheese; butter; cream; skim milk; casein and other glues; gelatin; hides; bone meal; other bone products; vaccines; other medicinals.
Chillies	Spices.
Coffee	Coffee beverage concentrates.
Corn	Starch; syrup; edible oil; tinned corn; frozen corn; alcohol; cosmetics; cornmeal; paper; wallboard.
Cotton	Textiles; paper; other fiber products; oil; meal; cake.
Flowers	Perfumes
Agricultural Raw Materials (contd.)	*Principal Manufactured Products*
Fruits, miscellaneous, edible, fresh	Canned, quick-frozen and dried fruits; juices; squashes; confections; jams and jellies; flavourings.
Goats	Hides; fibers; bone products; glue; dairy products.
Groundnut	Edible oil; meal; cake; oleomargarine; tinned grounds.
Hemp	Fibers.
Hogs	Hides; hair; bone products; glue; lard; tallow.
Horses	Hides; hair; bone products; glue; vaccines.
Indigo	Dyes.
Jute	Sacks; cordage; burlap yard goods; upholstery stripping; linen-like textiles for clothing and other purposes.
Millet	Millet rice substitute.
Mulberries	Silk; high-grade paper; wood products.
Palms, coconut	Saponifiable oil; edible oil; soap; fiber products; cosmetics; confections; copra.
Palms, dhani	Roofing; beverage; alcohol.
Palms, toddy	Jaggery; beverage; alcohol; fiber products.
Pigs (see hogs)	
Plantains	Dried, powdered, tinned bananas; oils; alcohol; pulp and paper.
Potatoes	Dehydrated potatoes, flour; starch; glucose; alcohol.
Poultry	Dressed fresh poultry; cured poultry; dried eggs; albumin; feather products.
Rape	Oil; meal; cake.
Rice and rice straw	Milled rice; parboiled rice; rice bran; rice bran oil; oil cake; wallboard; rope and other straw products; rice flour; noodles; confections; wine.
Rubber	Rubber products; paints; rubber cement.
Sesamum	Edible oil; meal; cake, oleomargarine.
Sheep	Hides, fibers; bone products; glue; gut.
Soy beans	Edible oil; meal; cake; oleomargarine; milk substitutes; curd; sauce; paste.
Sugarcane	Sugar; syrup; wallboard.
Sunflowers	Oil; meal; cake.
Tea	Tea; tea concentrates.
Tobacco	Cigarettes; cigars; cheroots; snuff; chewing tobacco; smoking tobacco; insecticides.
Tung	Drying oil; paints.
Vegetables, miscellaneous, fresh	Canned, frozen and dried vegetables; oils; pickles; dyes.
Wheat	Bread; bakery products; flour; monosodium glutamate; bran

Fishery and Related Raw Materials	*Principal Manufactured Products*
Fish, fresh and salt-water (including fish farming in ponds and paddy fields)	Canned fish; dried and cured fish; edible powdered dried fish; fish liver oil; fish meal fertilizer.
Crustacea and mollusks	Canned prawns and other crustacea; buttons.
Seaweed	Fertilizer.

Forest Raw Materials	*Principal Manufactured Products*
Note: Tree products—e.g. coconut, rubber—which are generally grown on an organized plantation basis are listed under Agricultural Raw Materials.	
Bamboo	Paper; rafting material; building framing material (untreated and impregnated); building sidings; furniture; floor mats, etc.
Camphor	Drugs.
Cane	Rattan work; baskets; mats; cordage substitute.
Cinnamon	Spices.
Cutch	Tanning agents; dyes.
Hardwoods, not elsewhere classified	Squares, sawn untreated timber and lumber; impregnated timber and lumber; lumber products; chipboard (from sawmill wastes); plywood; tea chests; railway sleepers and keys; charcoal; firewood. Gurjan has most of the characteristics of teak.
Lac	Shellac; sealing wax; phonograph records; varnishes.
Leaves, miscellaneous	Wrapping materials.
Mangrove	Tannin; firewood.
Pyinkado (iron wood)	Untreated and impregnated railroad sleepers; posts; construction timber; tool handles.
Sandalwood	Carvings; chests; fans.
Softwoods, miscellaneous	Matches; boxes.
Teak	Ship and boat decking; timbers and hull planking; building construction; timber and lumber; lumber products; shingles (from butts); chipboard (from sawmill wastes); plywood; furniture.
Thitsi	Lacquers; varnishes; cements.
Vines, miscellaneous	Rope and cordage substitutes.

*Note: (1) In connection with all minerals listed in this and the following section, for which only minor occurrences are indicated, it must be remembered that Burma is still underexplored for minerals.

(2) Up to the present most of the ores of metallic minerals have been shipped abroad as concentrates. Lead and silver have been refined to elemental metallic form in Burma.

*Metallic Mineral Raw Material**	*Principal Manufactured Products*
Aluminum (no encouraging deposits of bauxite found in Burma to date)	—
Antimony (slight exploitation to date, but potentially valuable deposits)	Bearings; batteries; type; collapsible tubes; foils, solder; tracer ammunition and primers; paints and lacquers; glass and pottery; matches.
Beryllium (small deposits of beryl ore; no primary deposits known to exist in Burma)	Alloy steels; nonferrous alloys; fluorescent phosphors; incandescent lamp filaments and filament coatings; other heating elements; special crucibles and refractories.
Barium and barites (known deposits in several places including near Mawson in Shan States; some small-scale commercial output in the past)	Sludges for well-drilling; paint filler; glass; rubber filler; steel heat-treating agent; photographic paper coatings; brine purifier for chlorine manufacture; green signal flares; beet sugar purifier; hydrogen peroxide manufacture; steel case hardening.
Bismuth (found in small quantity in wolfram-bearing alluvial deposits of Tavoy and Mergui areas; also in the tin-wolfram lode at Kanbauk)	As elemental bismuth, used for medicines; cosmetics; manufacture of thin-walled tubing; seals for nitriding furnaces; electroforming; additive to aluminum alloys; additive to stainless, manganese, and carbon steels; fuze alloys and other low melting point alloys; rectifier coatings; tin-saving solders; bearings. As bismuth subcarbonate, used for ceramic glazes and artificial horn products; as basic bismuth chloride, used for cosmetics, paint pigments and artificial pearls; as basic bismuth nitrate, used for bismuth fluxes for enamels and cosmetics.
Chromium (several occurrences of chromite reported in Arakan Yomas, and several others in Kamaing subdivision of Myitkyina district; no commercial output in Burma to date)	Heat and corrosion resisting alloy steels; nickel chrome resistance wire; tanning compounds; dyeing mordants; oxygen absorber in gas analysis; camouflage pigments; priming pigments for military aircraft, vessels and structural steel; textile processing plating and anodizing aircraft parts and frames; catalysts for petroleum refining; synthetic rubber manufacturing refractories; reagents and chemicals.
Cobalt (no cobalt deposits as such known in Burma, but cobalt forms important part of complex Bawdwin mine ores)	High speed steel alloys; magnets; paint pigments; and porcelain paints; absorbent for military poison gas and ammonia.
Columbium (E. L. G. Clegg, Superintending Geologist, Geological Survey of India, states one specimen of columbite bearing pegmatite found in north of Tavoy district; no large occurrences known in Burma, and no commercial extraction to date)	Corrosion resisting stainless steels.
Copper (only minor occurrences known except for copper constituent of complex Bawdwin ores)	Many major fabricated copper products; many major fabricated brass and bronze products; other copper alloys; paint and paper pigments; roofing specialities; pins; clips; staples; zipper fasteners; insecticides and exterminators; pyrotechnics; artificial flowers; photographic reagents; dyeing mordants; artificial silks; colored glass; electrodes; steel rust retardant; many chemicals; many medicines and drugs.
Gold (only minor alluvial deposits so far known in Burma)	Gold leaf; jewelry and watch cases; dentistry; pens and pencils; church articles; military insignia; stained glass, many gold plated articles; chinaware and porcelain decoration; gilding liquids; photography; drugs.
Iridium (see platinum)	
Iron (some 21 iron-ore deposits have been reported in Burma; none of any size has as yet been found; from 1934	Basic iron and steel manufactured and semi-manufactured products include pig iron, in various grades; ferro-alloys for a variety of

Metallic Mineral Raw Materials (contd.)	*Principal Manufactured Products*
through 1940 the Burma Corporation produced around 25,000 tons per year of iron ore from Burma deposits; practically all of this was used as flux in smelting lead and associated ores from Bawdwin mine; extraction of iron ore for flux should be revised; additional reported deposits, especially in the Tavoy and Loikaw areas, should be investigated; scrap, a source of raw material for the iron and steel industry which has recently been under survey)	purposes; steel ingots, blooms, billets, slabs and sheet bars; iron and steel bars and rods, including iron bars, steel concrete reinforcement bars, other steel bars, and wire rods; iron and steel plates, sheets, skelp and strips; iron and steel sheets, galvanized and ungalvanized; tin plate and terne plate. Manufactured steel mill products including structural iron and steel; railway track material; pipe and other tubular products; wire and manufactures; nails and bolts; castings and forgings. Manufactured iron and steel products, other than steel mill products, include tools, other hardware and a large share of the other manufactured products of present-day industrialized economies. Other iron products and derivatives include iron powder, used for batteries, powder metallurgy, veterinary medicals; iron carbybal, used as an antiknock in internal combustion engines; brown iron oxide, used for animal feeds, ceramics, water-paints; red iron oxide, used for polishing glass and metal, pigments in rubber goods, wallpaper pigments, iron paints, ceramics; ferric ammonium citrate, used for blueprints, medicinals and photography; ferric chromate, used for porcelain ceramics and for pigment in paints, varnishes, water colors; ferric dichromate, used for water and oil paints cement paint and green pigment; ferric ferrocyanide, used for paint pigments and for ink and laundry bluing; ferric hydroxide, used for pigments, medicinals, and as a gas absorber; ferric nitrate, used for tanning, textile dyeing mordant, weighting silks; ferrous chloride, used for dyeing and as mordant in textile printing; ferrous sulphate used for inks and dyes, pigments, dyeing and tanning, water purifying, indigo reduction, photography, wood preservative, fertilizers, disinfectants and for making other iron salts; ferrous sulphide, used for making sulphuric acid and as antidote for certain poisons.
Iron pyrites (see below under Sulphur)	
Lead (large deposits of lead-bearing ores at Bawdwin; these have supported large-scale lead production and export; other known deposits may also offer commercial promise; Burma output ran 70–80 thousand long tons of lead per year, 1936–39)	Refined lead metal: ammunition; bearing metals; brass and bronze; cable covering; calking; casting metal; collapsible tubes; foil; solder; storage batteries; terne plate; plumbing supplies. Antimonial lead: bullet case rod; battery lead; industrial vessel linings. Lead pigments: storage batteries; insecticides; ceramics; paints; oil refining; rubber; varnish; linoleum; ink. Other lead-salts, chemicals, derivatives: textile dyeing, printing, weighting; putty; pyrotechny; manufacture of matches and explosives; "antiknock" for gasoline; numerous drugs; many other products.
Manganese (promising deposit near Ho Pong; other reported deposits also being investigated; some commercial exploitation to date)	Many ferrous alloys; manganese bronze; depolarizer in dry batteries; glass; enamels; paints; varnish dryers; dyes and mordants; fertilizer (agricultural manganese sulphate); leather processing; disinfectants; decorating porcelain and china; pigments in rubber products; drugs.
Molybdenum (no deposits of molybdenum as such known in Burma; some recovered as byproduct in mining and milling of tin and wolfram ores)	Ferrous alloys; pigments and colors; welding rod coatings; filaments, screen-grids for electronic devices; ceramic glazes; chemical reagents.
Mercury (there have been rumors, according to Clegg, of cinnabar mercury ore deposits in the Shan States and Tenasserim; but to date there is no clear evidence of occurrences	—
Monazite (some occurrences of monazite sands reported in Burma, but so far of doubtful commercial value)	Monazite sand the commercial source of the cerium group (the so-called "rare-earth minerals"), consisting of cerium, lanthanum, praseodymium, terbium, yttrium, illinium, and samarium. These made into various alloys, of which the most important (cerium standard alloy) used in lighter flints (spark metal); tracer bullets; electronic tubes; aluminum and magnesium alloys; glass; catalysis in ammonia manufacturing; aniline black; medicals and pharmaceuticals. Oxide, hydrates and fluorides of the rare-earth minerals are used in cores for carbon arc electrodes; special optical glass; glass polishing; miscellaneous chemical compounds. Monazite sands are also a source of thorium, a radioactive element used in X-ray work, mantles for petrol pressure lamps, and as raw material for manufacture of atomic bombs.
Nickel (only known source in Burma is in complex Bawdwin ores, which yield nickel upon treatment abroad; total Burma nickel speiss output ran 3–4 thousand long tons annually 1936–39)	Nickel pig, ingots and shot (granules); bars; rods and tubes; nickel oxide, stainless steels and other nickel-steel alloys; nickel silver (German silver); nickel-chrome electrical resistance wire; nickel salts and compounds; copper-nickel alloys; monel metal (copper - nickel - iron - manganese alloys). Nickel and its salts and compounds also used in plating; coinage; electrotypes; storage batteries; telegraph magnets; lightning rod tips; electrodes and electrical contacts; spark plugs; machinery parts; bearings; fats

Metallic Mineral Raw Materials (*contd.*)	*Principal Manufactured Products*
	and oils hydrogenation catalysis; ceramic colors and glazes; inks; sun fast pigments in paints, lacquers, cellulose compounds, and cosmetics; porcelain painting, blackening zinc and brass; medicinals and pharmaceuticals.
Platinum and iridium (these metals occur in some of the gold-bearing sands of Burma; apparently no commercial production to date)	Elemental platinum metal used for spinnerets for glass fiber and rayon; laboratory ware; jewelry and watches; incandescent bulbs; electrolytic apparatus; dentistry; pyrometers; thermocautery, catalyst and deoxidizing agent. Platinum salts and compounds used for platinum plating; photography: platinum mirrors; relief etching of zinc; indelible ink; ceramic and glass lusters; X-ray apparatus. Iridium used for alloying with platinum and for tips of gold pen points.
Silver (recovered in significant commercial quantities from Bawdwin ores and as by-product of mining lead and zinc ores in Shan States; other occurrences also likely in Burma)	Coinage; photography; electrical appliances; bearings; military insignia; solders and brazing alloys; silverware; jewelry; watch cases; religious articles; pens and pencils; mirrors; medical and dental supplies; sterilizing water; silver plating; sympathetic and indelible inks; hair dyes; porcelain coloring; ivory etching; chemical reagents; pharmaceuticals.
Tin (about one third of large prewar output recovered from ores of Mawchi mines in Kayah State; many other smaller mines; dredging operations have been conducted in Tenasserim Peninsula; output of concentrates around 7,000 long tons per year, 1936-39)	Elemental tin metal used for tin plate; terne plate (lead and tin); solder; babbitt; bronze and brass; collapsible tubes; lining; foil and powder; chemicals; pipe and tubing; type metal; galvanizing; bar tin; white metal; pewter; other alloys. Tin as stannic chlorides used for mordant; fabric dyeing, weighting silk, electrolytic tinning; colors; silvering glass; organic synthesis. Tin as stannic oxide used for polishing glass and metals; manufacture of ruby glass; enamels and pottery; putty; mordant in printing and dyeing textiles; nail polishes. Tin as stannic sulphide used for gilding and bronzing metals, gypsum, wood and paper.
Tungsten (closely associated with tin-bearing ores in Burma so that occurrence and exploitation pattern conforms to that of tin as given above; prewar output of 7-9 thousand long tons annually of concentrates 1936–39)	Ferrotungsten alloys for high speed cutting tools; tungsten metal powder; tungsten white metal; gun metal (tungsten-manganese-copper); lamp filaments; phonograph needles; contact points for automotive telegraphic and electronic apparatus; tungsten-iron magnet alloys; as tungsten trioxide, for manufacture of tungstates for X-ray screens and for fireproofing fabrics; as sodium tungstate for fireproofing and waterproofing fabrics and for preparation of complex tungsten compounds and reagents.

Metallic Mineral Raw Material (*contd.*)	*Principal Manufactured Products*
Zinc (Bawdwin mine only present commercial source in Burma; prewar zinc concentrate output of Bawdwin ran 60–75 thousand long tons per year, 1936–39; a large deposit of zinc carbonate recently found at Lough Keng, southern Shan States)	Elemental zinc metal used for galvanized products; brass products; zinc-base alloy products; rolled zinc products; zinc castings; wet and dry batteries; desilvering lead; light metal alloys; zinc dust; bronze powder; gold extraction by cyanide process; manufacture of sodium hydrosulphite for use as bleaching agent for soaps and straw, and as reducing agent dye remover. Zinc chloride used for deodorants; disinfectants and embalming fluids; wood preserving, especially railway sleepers; fireproofing lumber; soldering fluxes; etching metals; manufacture of parchment paper, artificial silk, dyes, activated carbon, cold water glues and vulcanized fiber; galvanizing, browning and copper-plating iron and steel; magnesia cements; petroleum refining; cement for metals and facing stone, mordants in textile dyeing and printing; crepe and crimping fabrics; mercerizing cotton; sizing and weighting fabrics; vulcanizing rubber; solvent for cellulose; dehydrating agent; medicinal uses. Zinc sulphate used for mordants in cotton textile printing and dyeing; paint and varnish processing; rayon manufacturing; preserving wood and skins; paper bleaches; clarifying glue; agricultural sprays and fertilizers; electro-galvanizing; manufacture of other zinc salts and chemical and metallurgical reagents. Zinc sulphide used in pigments for paints, oilcloth, linoleum, leather and dental rubbers and for X-ray and television screens. Lithopone (a white pigment consisting of zinc sulphide, barium sulphate, and zinc oxide, used for paint pigment, as component of lithopone and otherwise); cosmetics; driers; quick-setting cements, including dental cements; opaque glass and some types of transparent glass; enamels; automobile tires; white glue; matches; white printing inks; porcelains; chemical reagents; and pharmaceuticals.

Non-Metallic Mineral Raw Materials	*Principal Manufactured Products*
Amber (only commercial source in Burma has been in Myitkyina district; a few other small, untested deposits)	Jewelry, costume jewelry and related products.
Asbestos (no deposits of commercial size yet found in Burma; a few known minor occurrences)	Asbestos-cement products, including roofing, wallboard and pipe; fire-resistant textiles; lime silica high temperature insulation; brake linings and clutch facings; pipe covering and cement; paper, millboard, rollboard, textiles, yarn and packing.

Non-Metallic Mineral Raw Materials (contd.)	*Principal Manufactured Products*
Clays and kaolin (numerous deposits, including a few rich in kaolin, now being worked; a large kaolin deposit reported in Lower Chindwin district; a fire-clay deposit reported near Moulmein; many other deposits of various types)	Common and face brick; hollow building tile; agricultural tile; roofing and floor tile; chemical brick and rings; china and chinaware; porcelain and semi-porcelain ware; glass melting pots; ornamental tiles; spark plugs; pigments and pigment bases and fillers; filler in paper manufacture; filler in rubber manufacture; cosmetics, polishing agents; special refractories; dental cements; glass industry.
Coal (large deposits of subbituminous coal in Kalewa area; also other deposits possibly including some cokable coal in Shan States; no significant commercial production hitherto; mining of Kalewa deposits planned for near future)	Briquettes for domestic use; industrial fuel for use (to an extent to be determined) in electric power utilities, railroads, steel and rolling mills, cement plants, coal-gas retorts, beehive coke ovens, by-product coke ovens; organic chemicals.
Corundum (according to Clegg there has been commercial extraction of corundum or natural alumina as by-product of gem stone output of the Mogok mines)	Abrasives.
Gem stones (rubies, sapphires and spinels the major gem stones of Burma; all these come mainly from Mogok area; some rubies have also been found in the Sagyin Hills, north of Mandalay, and in Nanyaseik area, northwest of Myitkyina; semi-gem stones, including apatite, aquamarine, chrysoberyl, moonstone, peridot or chrysolite, garnet, lapis lazuli, quartz, and rubellite or red tourmaline are also found in Burma, mainly in the Mogok area)	All gem stones and semi-gem stones listed at left used in jewelry and related products; apatite, composed of calcium phosphate-fluoride, also used as source of certain phosphorous compounds; garnet used as an abrasive; quartz, composed of silicon dioxide, also used for glass manufacture, steel manufacture, sandblast sand.
Grinding media (rounded flint pebbles probably available from mountain streams on slopes of Shan Plateau and in north Burma)	Reduction grinding of pottery clays, feldspar, silica sands, other minerals.
Jade (jade mines in Myitkyina area have been worked from time immemorial; jade has also been produced in at least four other districts in northern Burma; total output of jade, large in prewar years, was small in 1949 and nil in 1950)	Semi-precious stones of considerable value.
Kaolin (see above, clays and kaolin)	
Limestone (found throughout most of eastern Burma, from the Tenasserim north; also at other points in Burma; deposits at present worked on a large scale near Thayetmyo and on a small scale at many places)	Limestone (composed of calcium carbonate), burned lime (calcium oxide), or hydrated line (calcium hydroxide) used for agricultural lime; mason's lime; plasterer's lime; chemical and industrial acid neutralization, manufacturing other alkalies; asphalt and other bitumens; bleaches; brick-making, calcium carbide; cyanamide; chromates and bichromates; purification of coke gas and other coke oven by-products; explosives; food processing, including dairies, gelatin, stock feed; deodorizing vegetable oils; glass manufacturing; glue; lubricating grease; insecticides, fungicides and disinfectants; magnesia; medicines and drugs; ferrous and nonferrous metallurgical flux; ore concentration; wire drawing; solid coating; paints; paper mills; including bleach; petroleum refining; rubber manufacture; salt refining; treatment of sewage and industrial wastes; soap and fats; sugar refining; tanneries; textiles; varnishes, water purification; wood distillation; alcohol, bromine; cement manufacture; photographic supplies; precipitated calcium carbonate; dicalcium phosphate; polishing compounds; retarders; rock wool; sulphur; tobacco; wool pulling; refractories.
Mica (some mica occurs near Thabeitkyin in Katha district, and along the Indaw River in Myitkyina district; according to Clegg, that from the former source is in small brooks, and that from the latter is in large brooks but is very much cleaved and strained; mica also occurs in Kachin State)	Block, sheet and punch mica used for capacitors; spark plugs; communications instruments; insulations. Ground mica used for roofing; asphalt mats; cable and telephone wire insulation; paints for water proofing textiles; wall paper; rubber; plastics; molded electrical insulation; building insulation; axle grease and oil manufacture; annealing metals; pipe line enamel; oil well drilling; welding; mica splittings used for stove and lantern windows and in-built form for molding plates for commutator rings; channels and mica tube; heater plates; segment plates; flexible insulating tape.
Ochre (occurs in a number of places in Burma. Clegg reports a deposit up to 30 ft. thick in the area of Myingyan; apparently no commercial exploitation to date)	Extensively used for paint pigment; cement additive; filler in linoleum and oilcloth; coloring for plastics, calcimine, stucco, cast stone, ceramic glazes.
Petroleum (bulk of production has been in Magwe area, but also some output at a number of other points; total Burma output in 1951 was 708,000 barrels, or about one tenth of prewar and much below present Burma domestic consumption)	Gasoline; kerosene; fuel oils; lubricating oils; waxes used for paper and paper produce manufacture, candles, sealing materials, etching and engraving, modeling, pattern-making and waterproofing and coating various products; petroleum coke for industrial fuels and domestic heating and cooking; asphalt; liquified gases used for industrial and domestic fuels and for rubber and chemicals manufacturing; liquid and solid petroleum; isopropyl alcohol; medicinals; a wide variety of other organic compounds.
Phosphate rock (no deposits known as yet in Burma)	—

Non-Metallic Mineral Raw Materials (contd.)	*Principal Manufactured Products*
Salt (no solid beds of sodium chloride, or rock salt, known to exist in Burma; most of Burma salt output is from evaporation of sea water, which is done on large scale at a number of points, especially in the Tenasserim and at Akyab and other Arakan coast points; salt also produced on small scale basis in central and northern Burma by evaporation of natural inland brines)	Sodium chloride used for chlorine and bleaches; soda ash; dyes and organic chemicals; soap precipitant; textile processing; hides and leather; meat packing; fish curing; dairy products; other food processing and preserving; refrigeration; livestock; dust and ice control for highways, railroads, airports; table and household uses; water treatment; agricultural uses; source of a number of manufactured sodium compounds, of which the following are most important: sodium acetate used for photography; dyeing mordant; thermos bottles; chemical reagents; sodium aluminate used for white glass; soap, building stone hardening; water softening. Sodium bicarbonate used for manufacture of carbon dioxide; fire extinguishers; baking powder; effervescent salts; cleaning compounds; manufacture of other sodium salts. Sodium bisulphite used for bleach and disinfectants; dyeing; paper manufacturing; soap stripper in laundering; coagulant for rubber latex; fermentation industries. Sodium borate used for soldering; glazes and enamels; tanning; cleaning compounds; preservatives; fireproofing. Sodium bromide for gold solvent. Sodium bromide used primarily in photography. Sodium carbonate used for glass manufacture; soap manufacture; wool washing; linen and cotton bleaching; water softening; photography; as chemical reagent and for manufacture of other sodium salts. Sodium chlorate used for explosives; matches; dyeing and printing fabrics; leather tanning and furnishing; weed killers; oxidizer in dye manufacture. Sodium cyanide used in metallurgy of gold and silver; electroplating baths; fumigant; case hardening steel; hydrocyanic acid manufacture. Sodium fluoride used as disinfectant; insecticide; preserving wood; paste and mucilage. Sodium nitrate and other nitrates used in manufacture of nitric acid; as catalyst in sulphuric acid manufacture; fertilizers; glass; pottery enamels; smoking tobacco; meat pickling. Sodium sulphate used for paper-making; textile dyeing and printing; freezing mixtures; standardizing dyes. Sodium sulphide used for artificial soil manufacture; dyeing; hide dehairing; dye manufacture; rubber manufacture; engraving and lithography. Sodium sulphide used for photography developer and fixature; bleaching wool, straw and silk; generating sulphur dioxide gas; dyes; silvering glass; paper manufacturing; food preservation.
Sand, glass (some 360,000 tons of iron-free glass sands estimated to be available in northern Mergui Archipelago; reported deposits in southern Mergui Archipelago and in Kachin States also being investigated	Glass products.
Sand, other (molding sands found near Rangoon and perhaps elsewhere in Burma; sand suitable for general concrete work and other purposes found in many parts of Burma)	Molds for metallurgical casings; concrete; mortar; other construction and paving applications; grinding and polishing; refractory sands; engine traction sand; filtering.
Sodium sulphate (main known sources are brines of Yega Lake, near Mandalay, and waters near Bawgyo, Northern Shan States)	See under Salt.
Stone, building, miscellaneous (granite and gneiss, laterite, limestone, sandstone and trap rock are found in various parts of Burma; white marble available from Sagyin Hills, north of Mandalay)	Construction.
Sulphur (no known deposits of elemental sulphur in Burma; minor occurrences, probably of no economic importance, of hydrogen sulphide and of iron pyrites containing some 53% sulphur; sulphur in form of sulphuric acid may be by-product of proposed electrolytic reduction of zinc in Burma	As elemental sulphur, used as raw material for fertilizers; insecticides; pulp and paper industries; explosives; dyes and coal tar products; rubber; paints and varnishes; food products; vulcanizing; plastics; bleaching; medicinals; manufacture of sulphuric acid, sulphites and other chemicals. As sulphuric acid, used for petroleum purification; chemicals; coal tar products; iron, steel and other metallurgy; paints and pigment; industrial explosives; rayon and cellulose film; textiles; parchment paper; glue.
Talc (talc formerly produced near the town of Minbu on the Irrawaddy River; these mines abandoned; additional deposits may exist in Burma)	Insecticides; paper; roofing; rubber manufacture; toilet preparations; refractories; plaster; insulation; bleaching; mine and sawing dust; textiles; panels and switchboards; soap lubricants; ceramics; foundry facings; nonreflecting paints; metal workers' crayon; blackboard pencils.

2. INDUSTRIAL PRODUCTS FOR POSSIBLE MANUFACTURE IN BURMA

To assure a comprehensive review of the industrial potential of Burma, an independent check list of products and processes was compiled. This list was derived from a complete tabulation of manufactured products published by the United States Bureau of Census, reduced to include those products and processes that, because of the raw materials available and conditions existing in Burma, appear to warrant consideration in an ultimate industrial development.

TABLE XXII – 2

INDUSTRIAL PRODUCTS FOR POSSIBLE MANUFACTURE IN BURMA

Food and Kindred Products
- Meat packing
- Condensed and evaporated milk
- Fishing industry (canned fish)
- Flour and other grain-mill products
- Prepared foods (including mineral) for animals and fowls
- Rice cleaning and polishing
- Sugar
- Cooking and other edible fats and oils
- Oleomargarine

Tobacco Manufactures
- Cigars
- Cigarettes
- Pipe tobacco

Textile-Mill Products and other Fiber Manufactures
- Cotton manufactures
- Knit goods
- Dyeing and finishing textiles
- Jute goods (except felt)
- Cordage and twine
- Household furnishings (except curtains, draperies and bedspreads)
- Canvas products

Lumber and Timber Basic Products
- Logging
- Sawmills, veneer mills and cooperage
- Planing and plywood mills

Furniture and Finished Lumber Products
- Household furniture
- Office furniture
- Public building furniture
- Laboratory, hospital and other professional furniture partitions, shelving, cabinet work and office and store fixtures, wooden containers
- Baskets for fruits and vegetables
- Rattan willowware and baskets other than vegetable and fruit baskets
- Cigar boxes: wooden, part wooden
- Wooden boxes except cigar boxes
- Cooperage
- Tea chests
- Window and door screens, shades, and venetian blinds
- Caskets, coffins, burial cases, and other morticians' goods

Miscellaneous Wood Products
- Excelsior
- Cork products
- Matches
- Wood preserving
- Lasts and related products
- Mirror frames and picture frames
- Wood products not elsewhere classified

Paper and Allied Products
- Pulp, paper and paperboard
- Converted paper products
- Coated and glazed paper
- Envelopes
- Paper bags
- Fiber cans, tubes and similar products
- Paperboard containers and boxes
- Die-cut paper and paperboard, and converted cardboard
- Wallpaper
- Converted paper products not elsewhere classified

Printing, Publishing and Allied Industries
- Newspapers
- Periodicals
- Books
- General commercial (job) printing
- Lithographing and photo-lithographing
- Greeting cards
- Gravure, rotogravure and rotary photogravure
- Bookbinding and related industries

Service Industries for the Printing Trades
- Machine and hand typesetting
- Engraving (steel, copperplate and wood); plate printing
- Photograving not done in printing establishments (including preparation of plates)
- Electrotyping and stereotyping, not done in printing establishments

Chemicals and Allied Products
- Paints, varnishes and colors
  - Paints, varnishes and lacquers
  - Colors and pigments
- Cottonseed oil, cake, meal and linters
- Soyabean oil, cake and meal
- Fish and other marine oils, cake and meal
- Vegetable and animal oils
- Drugs, medicines, toilet preparations, insecticides and related products
  - Drugs and medicines (including drug grinding)
  - Perfumes, cosmetics and other toilet preparations
  - Insecticides, fungicides and related industrial and household chemical compounds
- Soap and glycerin
- Hardwood distillation, charcoal and naval stores
  - Hardwood distillation and charcoal manufacture
  - Wood naval stores
  - Gum naval stores (processing but not gathering or warehousing)
- Fertilizers
- Plastic materials
- Salt
- Compressed and liquified gases—not made in petroleum refineries or in natural gasoline plants
- Chemicals—sodium sulphate
- Ammunition
- Candles
- Products of petroleum and coal
  - Fuels, oils and petrol
  - Fuel briquettes
- Coke and by-products
  - Beehive coke
  - Oven coke and coke-oven by-products
- Paving and roofing materials
  - Paving blocks and paving mixtures; creosoted, wood and composition
  - Roofing, built-up and roll; roof coating (except paint)
- Rubber products
  - Tires and inner tubes
  - Rubber boots and shoes
  - Reclaimed rubber
  - Rubber products not elsewhere classified
- Leather, tanned, curried and finished
- Footwear (except rubber)

Stone, Clay and Glass Products
- Flat glass
- Glassware, pressed or blown
  - Glass containers
  - Tableware, pressed or blown glass
- Cement
- Brick
- Roofing tile
- Floor and wall tile (except quarry tile)
- Sewer pipe and kindred products
- Clay refractories, including refractory cement (clay)

Stone, Clay and Glass Products (contd.)

- Pottery and related products
  - Vitreous china plumbing fixtures
  - Hotel china
  - Whiteware
  - Porcelain electrical supplies
  - China firing and decorating
  - Pottery products not elsewhere classified
- Concrete products
- Wallboard and wall plaster, building insulation, and floor composition
- Lime
- Asbestos products (except steam packing and pipe and boiler covering)

Iron and Steel and their Products, except Machinery

- Tin cans and other tinware
- Wire products
- Cutlery, tools and hardware
- Enamelled iron sanitary ware and other plumbers' supplies
- Heating and cooking apparatus, except electric
- Firearms
- Screw-machine products and wood screws

Nonferrous Metals and their Products

- Primary smelting and refining of nonferrous metals
- Alloying and rolling and drawing of nonferrous metals except aluminum
- Secondary smelting and refining of nonferrous metals and alloys
- Silverware and plated ware
- Aluminum ware, kitchen, hospital and household
- Aluminum products (including rolling and drawing and extruding)
- Sheet-metal work
- Electric lamps
- Batteries, storage and primary (dry and wet)

Machinery

- Agricultural machinery
- Machine-shop products
- Machine-shop repairs
- Railroad equipment
- Ship and boatbuilding and repairing
- Musical instruments and parts
- Toys and sporting and athletic goods
  - Games and toys
  - Dolls
  - Children's vehicles
  - Sporting and athletic goods
- Buttons
- Brooms
- Brushes
- Fabricated plastic products
- Umbrellas, parasols and canes
- Tobacco pipes and cigarette holders

3. MARKETING POTENTIAL

As neither the raw material list, nor the products and processes list, reflects market demand, a study was made to assess the market potentialities of Burma. This study was based principally upon a review of all imports and exports of the Union of Burma, both prewar and postwar. Considerable research was required to subdivide general classifications into minor commodity classifications in order that the types and grades of major commodities might be determined. The information on imports was supplemented by investigations of the use or consumption of commodities produced or manufactured nationally. The existing national manufacturing industrial plant was investigated wherever possible to determine its capacity and efficiency. Based upon data from the sources outlined above, estimates were made of the future market for each major commodity under consideration.

The raw materials list and the product and process list were cross checked and the surviving consolidated product list was checked against the market list. This procedure eliminated products for which there was little or no apparent demand in Burma, and raw materials required for the products which were eliminated. Products were deleted in other cases where the supporting raw materials were lacking.

The final list became the foundation for an industrial development program for the Union of Burma.

C. AN INDUSTRIAL DEVELOPMENT PROGRAM FOR BURMA

1. THE BASIC PROGRAM

A study of the final list of products revealed that in many cases one or more were related, being produced from the same basic raw materials, or from combinations of primary, and/or secondary products, stemming from the same or similar raw materials. These related products were arranged into groups based upon the use of raw materials. This allowed an entire related group to be treated as a single project. The economics of manufacturing related products in single manufacturing plants influenced this grouping.

An evaluation was made of all factors influencing the site selection for certain key industries. It was found that one should be located in or near Akyab, one near Myingyan, and others in the Rangoon area. Establishing the locations for these key industries also determined the locations of other related industries. The establishment of three primary industrial centers, one each in the Akyab, Myingyan and Rangoon areas, was found to be the optimum arrangement for an industrial development program.

These groupings are favorable from all industrial viewpoints, and are equally favorable from a social point of view. A dispersion of industrial development is needed to promote the welfare of the interior and coastal regions of Burma.

The ramifications of the relationships between the groups of industries manufacturing products stemming from more or less similar raw material sources, and between other industries, comprising the industrial development program, were so complex that it was difficult to visualize them.

To facilitate the study of the industrial development program, and to clearly present the entire program so it could be easily understood, the complete program was reduced to graphic form. The master chart on which the program is outlined, is reproduced here in five plates entitled, "Projected Industrial Development of Burma." The master chart is divided into three major industrial groups centering on Akyab, Rangoon and Myingyan, and shows each major industry, the basic raw materials required for the manufacture of its products, and the minor industries which are dependent upon it (see Plates Nos. 1 to 5).

It will be noted that 45 major projects have been included in the plan. It must not be assumed that all are recommended for immediate or near future implementation. The chart was prepared to permit comprehensive consideration of the products that may be made from indigenous raw materials, to show the relationship and interdependence between the various industries, and to show the minor industries that can or should be developed after the products of the major industry become available. Each project, major or minor, must be investigated separately as to its economic feasibility, including market demand, probable cost of its manufactured product in competition with imports, its value to the country from the viewpoint of self-sufficiency, its dependence upon supporting industries, and other pertinent factors that may vary with each case. There are several regional duplications of the charts where it appears uneconomical to ship products from one industrial area to another.

The chart includes some projects in the field of mineral development and some existing industries, shown to present the over-all industrial picture, to show possible sources of products required by the included industries, and to indicate uses for industrial products.

Certain projects are impractical if other projects, not included in the master program, are not implemented. The fertilizer or ammonia chemical projects (Nos. 42, 44, and 45) depend upon the Kalewa coal project. Others would be affected if the hydroelectric power projects are not constructed.

Project reports have been prepared for certain of the process groups, and for major and minor industries. These projects are discussed in brief form in the following sections.

a. The Akyab Industrial Group

The availability of low cost power from Saingdin Falls and the decision to establish the new pulp and paper factory at Ponnagyun, thirteen miles above Akyab, on the west bank of the Kaladan River, were the primary factors in selecting Akyab as the center of a new industrial development.

The establishment of the pulp and paper industry at this point will require the location of the supporting caustic chemical industry and related industries in the same locality. The major supporting raw materials for this group, bamboo, salt and limestone, are all located within reasonable shipping distances by water. The deep Kaladan River affords excellent harbor facilities for ocean vessels bringing in the necessary imported raw materials and fuel, for outbound shipments of finished products in either domestic or export movement, and will be used to bring bamboo to the plant site. Water and labor are available in abundance.

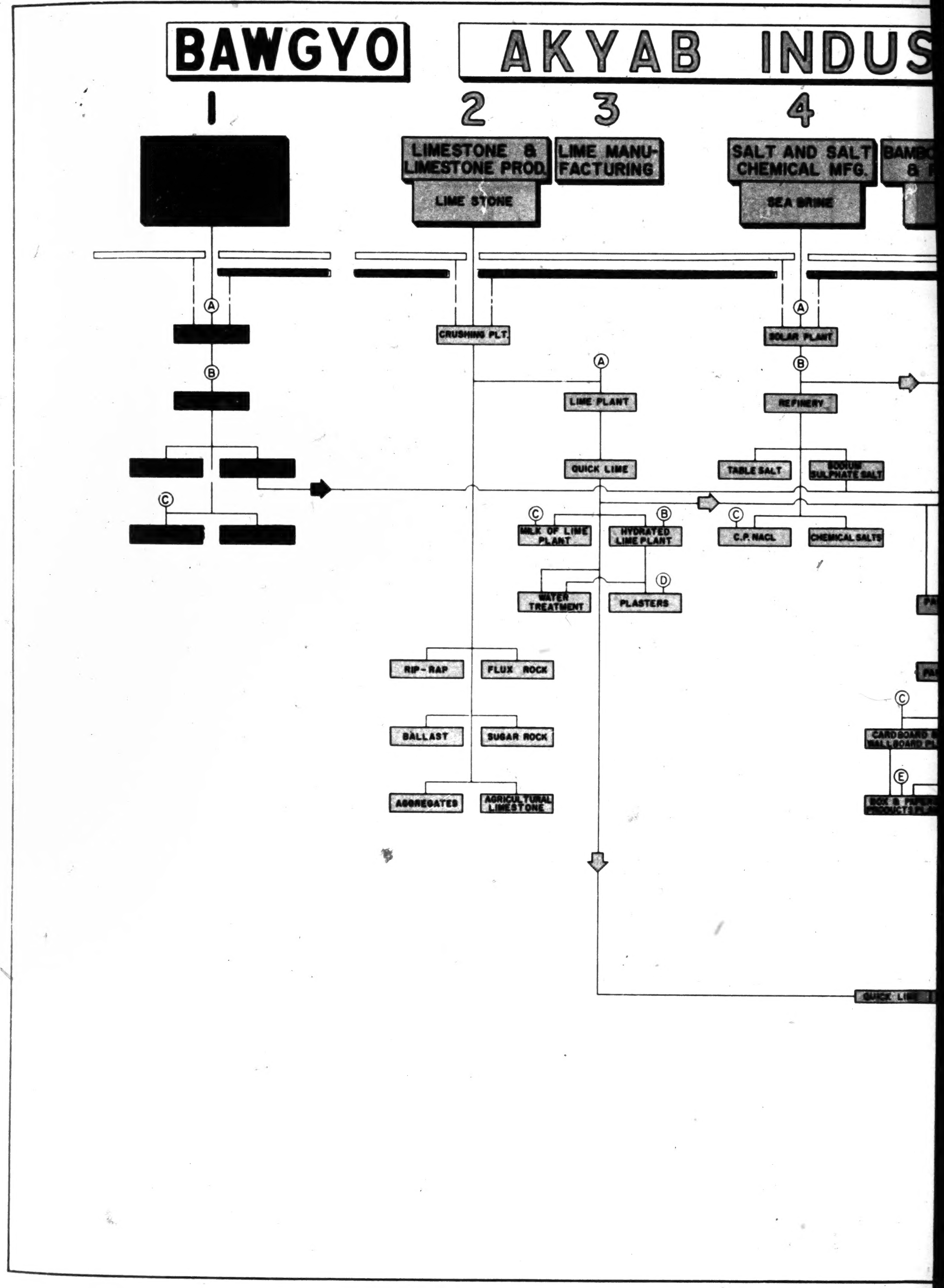
Akyab is also the important commercial city of the Arakan Division, which is isolated from central Burma by a long chain of high mountains. Like Rangoon, it is the seaport, industrial and distribution center for the western coastal area and the north-western part of Burma.

The establishment of these new industries in this important section of Burma will do much for its future growth and development. The projects to be included in this industrial district are:

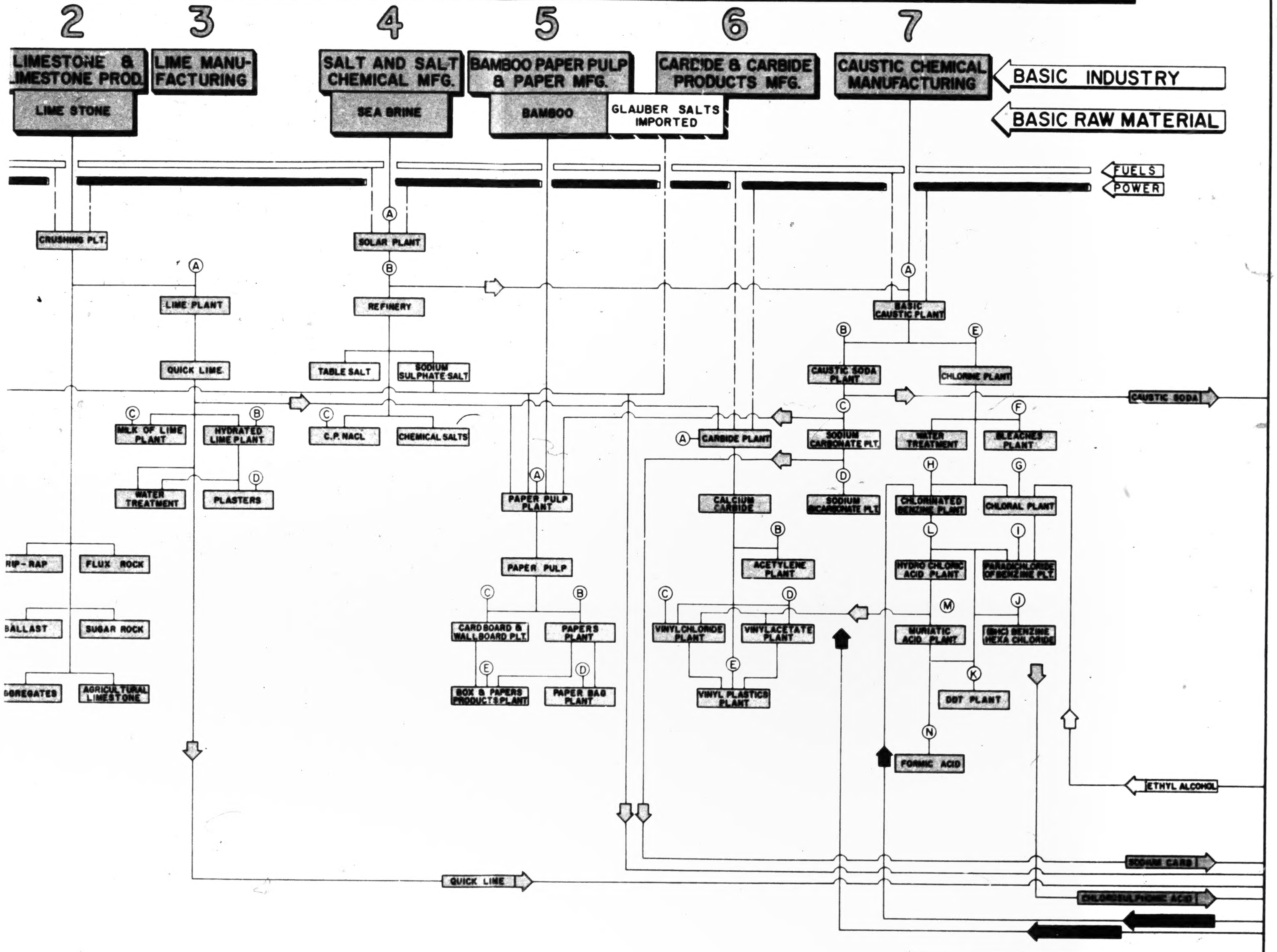
(1) Sodium Sulphate

Sodium sulphate is a material required for the operation of the projected pulp and paper factory. It is not recommended that this chemical be produced in Burma in the immediate future. During the initial stages of the operation of the pulp and paper factory, the chemical in the form of Glauber's salts will be imported. The only source of sodium sulphate known in Burma, at the present time, in commercial quantities is in the brines of Yega Lake, which contains roughly about 0·91% of the chemical. Investigation of the possibilities of solar and heat extraction of the salt indicated that its cost would be too high, particularly because of the great distance from the lake located in central Burma to the paper factory site above Akyab, via the Irrawaddy River.

It is recommended, however, that exploratory drillings be made under the supervision of a qualified geologist in an effort to find the vein or lode from which the salt is apparently leached. Such explorations have been common practice in other countries in the past and have successfully located subterranean deposits of common salt. If an appreciable subterranean deposit of sodium sulphate is found, and it is not too far below the ground surface, mining may result in a supply of salt at very low cost. If a deposit is found at a depth which precludes shaft mining, one of the conventional methods is to pump water into the deposit, obtain a saturated solution and evaporate the outflow to dryness. If a subterranean deposit of


BAWGYO
AKYAB INDUS
1
2
3
4
LIMESTONE & LIMESTONE PROD.
LIME MANUFACTURING
SALT AND SALT CHEMICAL MFG.
BAMBO
&
LIME STONE
SEA BRINE
A
B
C
CRUSHING PLT.
A
LIME PLANT
QUICK LIME
C
MILK OF LIME PLANT
B
HYDRATED LIME PLANT
D
WATER TREATMENT
PLASTERS
RIP-RAP
FLUX ROCK
BALLAST
SUGAR ROCK
AGGREGATES
AGRICULTURAL LIMESTONE
A
SOLAR PLANT
B
REFINERY
TABLE SALT
SODIUM SULPHATE SALT
C
C.P. NACL
CHEMICAL SALTS
C
CARDBOARD
WALLBOARD PL
E
BOX & PAPER
PRODUCTS PLA
QUICK LIME

AKYAB INDUSTRIAL DISTRICT

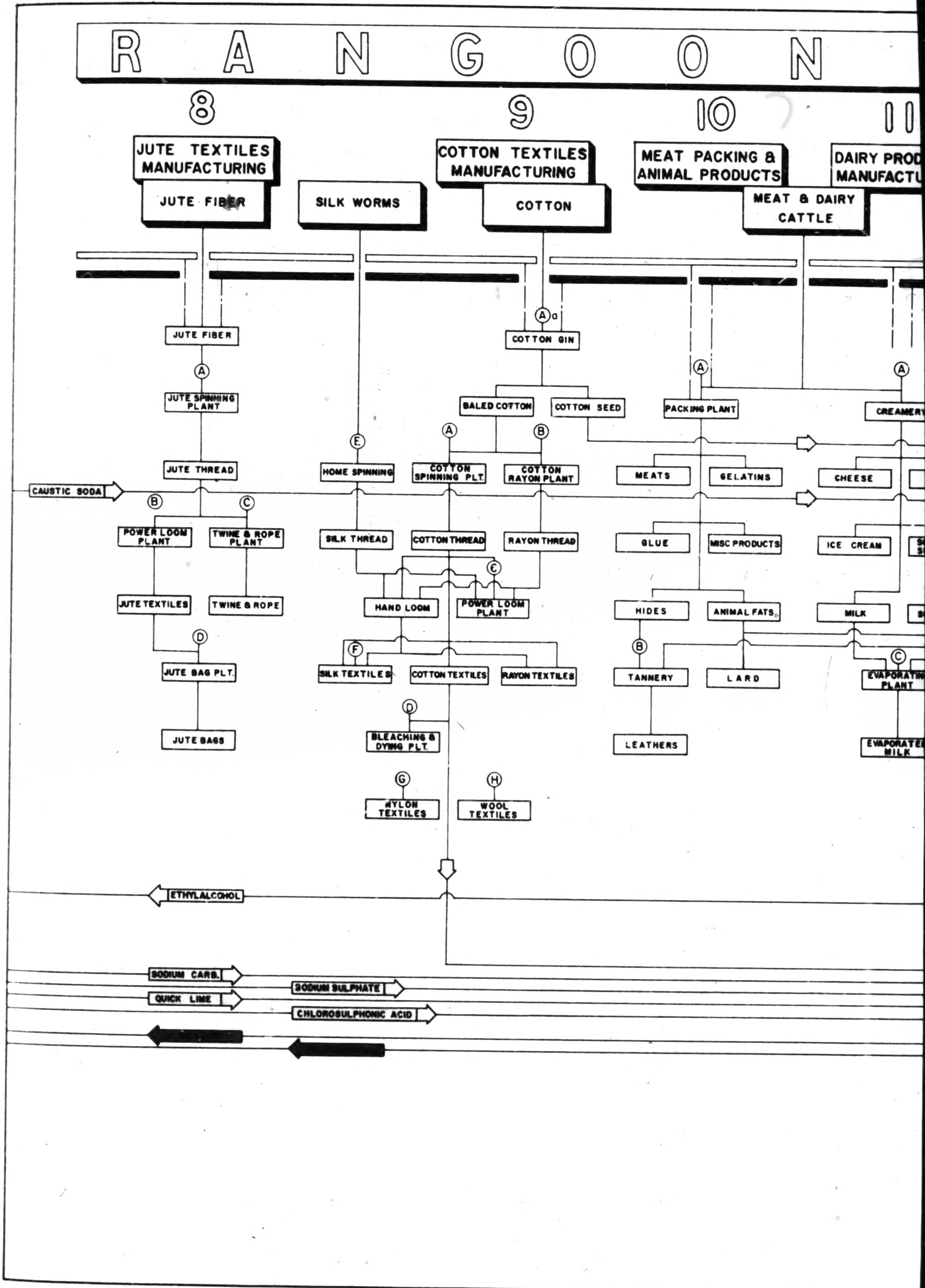

2
LIMESTONE & LIMESTONE PROD.
LIME STONE
3
LIME MANUFACTURING
4
SALT AND SALT CHEMICAL MFG.
SEA BRINE
5
BAMBOO PAPER PULP & PAPER MFG.
BAMBOO
GLAUBER SALTS IMPORTED
6
CARBIDE & CARBIDE PRODUCTS MFG.
7
CAUSTIC CHEMICAL MANUFACTURING
BASIC INDUSTRY
BASIC RAW MATERIAL
FUELS
POWER
CRUSHING PLT.
A
LIME PLANT
QUICK LIME
C
MILK OF LIME PLANT
B
HYDRATED LIME PLANT
WATER TREATMENT
D
PLASTERS
RIP-RAP
FLUX ROCK
BALLAST
SUGAR ROCK
GGREGATES
AGRICULTURAL LIMESTONE
A
SOLAR PLANT
B
REFINERY
TABLE SALT
SODIUM SULPHATE SALT
C
C.P. NACL
CHEMICAL SALTS
A
PAPER PULP PLANT
PAPER PULP
C
CARDBOARD & WALLBOARD PLT.
B
PAPERS PLANT
E
BOX & PAPERS PRODUCTS PLANT
D
PAPER BAG PLANT
A
CARBIDE PLANT
CALCIUM CARBIDE
B
ACETYLENE PLANT
C
VINYLCHLORIDE PLANT
D
VINYLACETATE PLANT
E
VINYL PLASTICS PLANT
A
BASIC CAUSTIC PLANT
B
CAUSTIC SODA PLANT
E
CHLORINE PLANT
C
SODIUM CARBONATE PLT.
D
SODIUM BICARBONATE PLT.
WATER TREATMENT
F
BLEACHES PLANT
H
CHLORINATED BENZINE PLANT
G
CHLORAL PLANT
L
HYDRO CHLORIC ACID PLANT
I
PARADICHLORIDE OF BENZINE PLT.
M
MURIATIC ACID PLANT
J
(BHC) BENZINE HEXA CHLORIDE
K
DDT PLANT
N
FORMIC ACID
CAUSTIC SODA
ETHYL ALCOHOL
SODIUM CARB
CHLOROSULPHONIC ACID
QUICK LIME

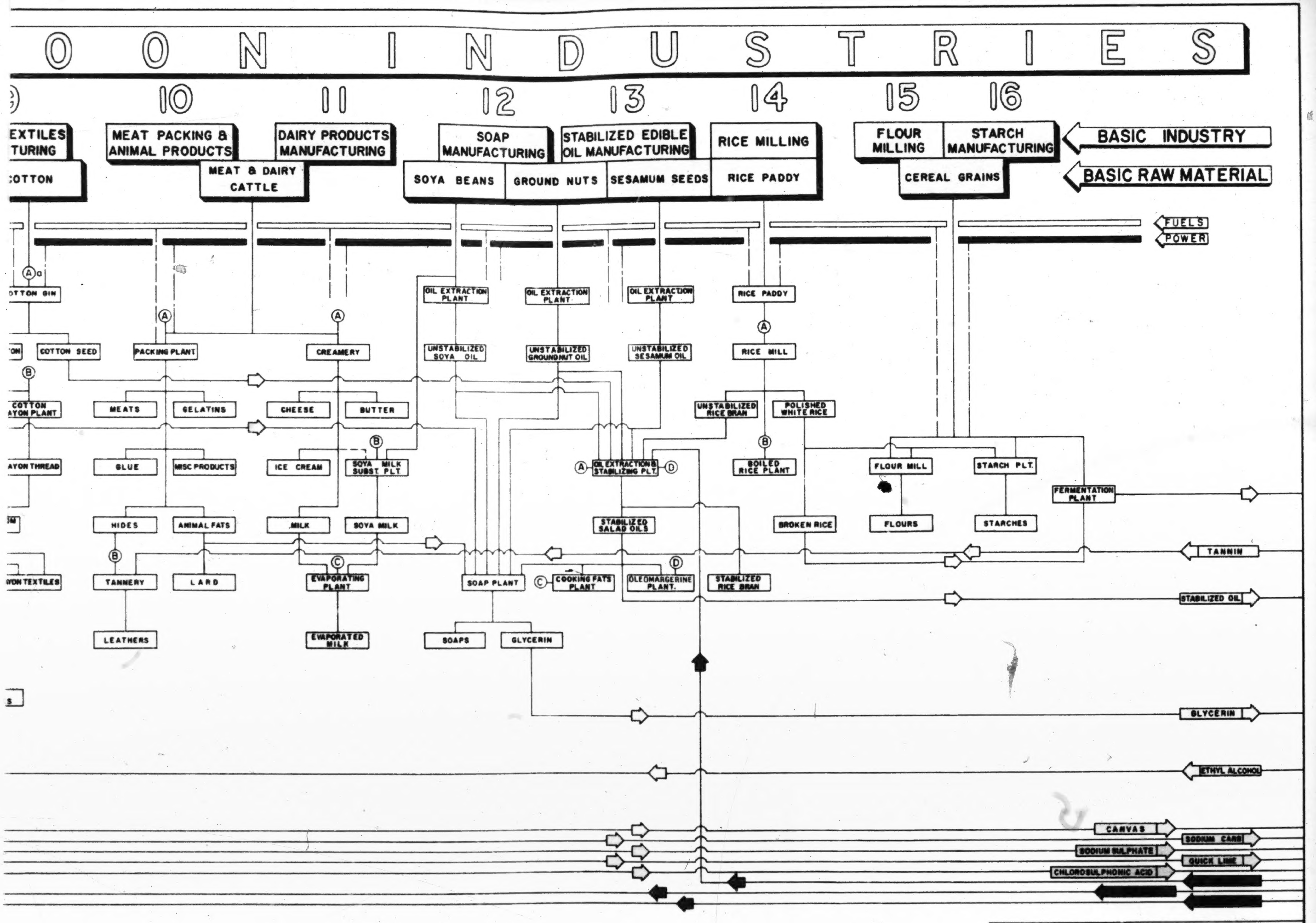
MINISTRY OF NATIONAL PLANNING

PROJECTED INDUSTRIAL DEVELOPMENT OF BURMA

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P.	DATE	PLATE
CK. BY C.M.C.	MAY 1953	NO. 1 OF 5


R A N G O O N
8
JUTE TEXTILES MANUFACTURING
JUTE FIBER
SILK WORMS
9
COTTON TEXTILES MANUFACTURING
COTTON
10
MEAT PACKING & ANIMAL PRODUCTS
MEAT & DAIRY CATTLE
11
DAIRY PROD
MANUFACTU
JUTE FIBER
A
JUTE SPINNING PLANT
JUTE THREAD
CAUSTIC SODA
B
C
POWER LOOM PLANT
TWINE & ROPE PLANT
JUTE TEXTILES
TWINE & ROPE
D
JUTE BAG PLT.
JUTE BAGS
E
HOME SPINNING
SILK THREAD
A a
COTTON GIN
BALED COTTON
COTTON SEED
A
B
COTTON SPINNING PLT.
COTTON RAYON PLANT
COTTON THREAD
RAYON THREAD
E
HAND LOOM
POWER LOOM PLANT
F
SILK TEXTILES
COTTON TEXTILES
RAYON TEXTILES
D
BLEACHING & DYING PLT.
G
NYLON TEXTILES
H
WOOL TEXTILES
A
PACKING PLANT
MEATS
GELATINS
GLUE
MISC PRODUCTS
HIDES
ANIMAL FATS
B
TANNERY
LARD
LEATHERS
A
CREAMERY
CHEESE
ICE CREAM
MILK
C
EVAPORATING PLANT
EVAPORATED MILK
ETHYLALCOHOL
SODIUM CARB.
SODIUM SULPHATE
QUICK LIME
CHLOROSULPHONIC ACID

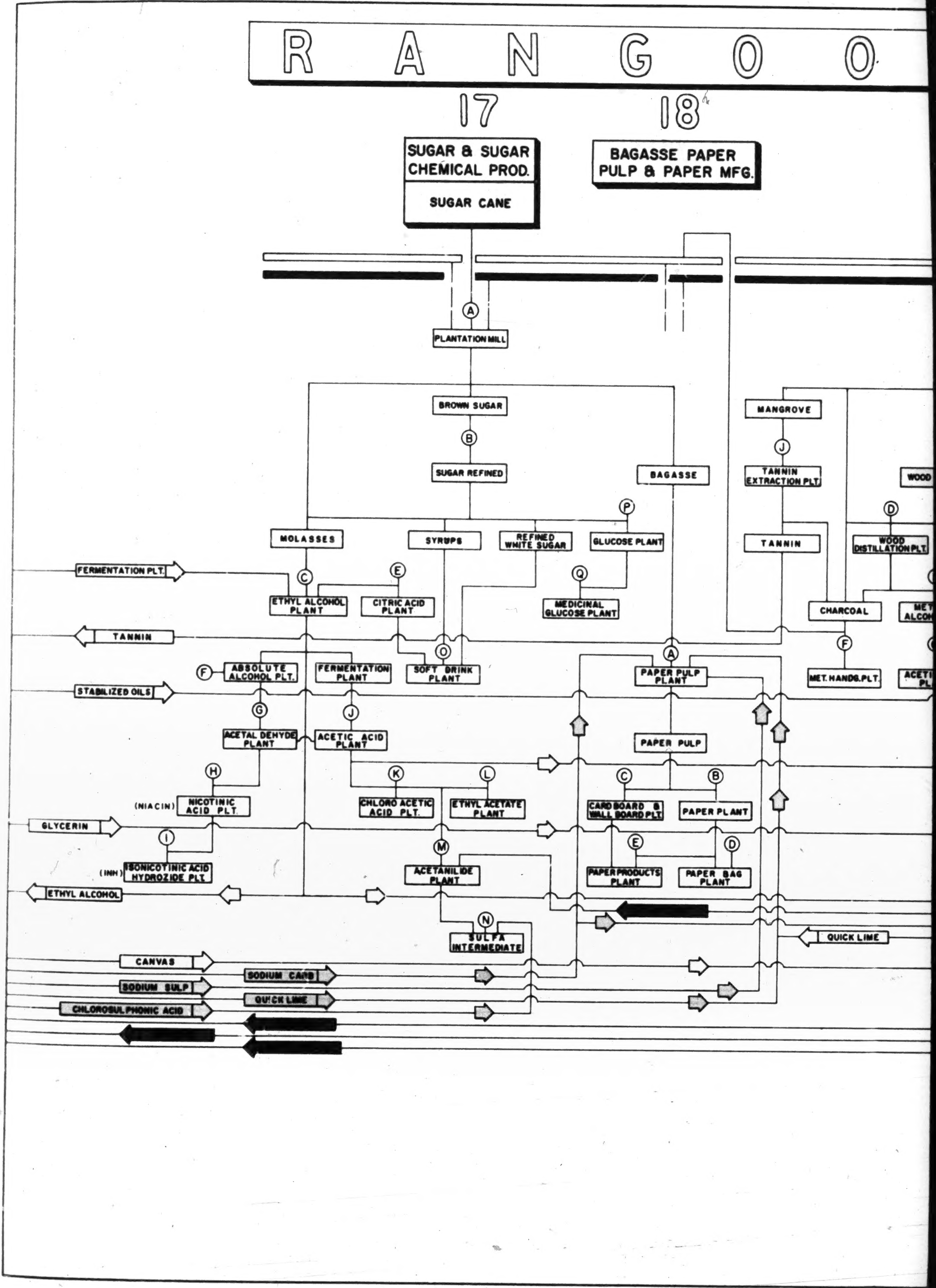

OON INDUSTRIES
9
10
11
12
13
14
15
16
EXTILES
TURING
MEAT PACKING & ANIMAL PRODUCTS
DAIRY PRODUCTS MANUFACTURING
SOAP MANUFACTURING
STABILIZED EDIBLE OIL MANUFACTURING
RICE MILLING
FLOUR MILLING
STARCH MANUFACTURING
BASIC INDUSTRY
COTTON
MEAT & DAIRY CATTLE
SOYA BEANS
GROUND NUTS
SESAMUM SEEDS
RICE PADDY
CEREAL GRAINS
BASIC RAW MATERIAL
FUELS
POWER
A
a
OTTON GIN
TON
COTTON SEED
B
COTTON
AYON PLANT
AYON THREAD
SM
YON TEXTILES
S
PACKING PLANT
MEATS
GELATINS
GLUE
MISC PRODUCTS
HIDES
ANIMAL FATS
TANNERY
LARD
LEATHERS
CREAMERY
CHEESE
BUTTER
ICE CREAM
SOYA MILK SUBST PLT
MILK
SOYA MILK
C
EVAPORATING PLANT
EVAPORATED MILK
OIL EXTRACTION PLANT
UNSTABILIZED SOYA OIL
UNSTABILIZED GROUNDNUT OIL
UNSTABILIZED SESAMUM OIL
SOAP PLANT
SOAPS
GLYCERIN
OIL EXTRACTION & STABILIZING PLT
D
STABILIZED SALAD OILS
COOKING FATS PLANT
OLEOMARGERINE PLANT
RICE PADDY
RICE MILL
UNSTABILIZED RICE BRAN
POLISHED WHITE RICE
BOILED RICE PLANT
BROKEN RICE
STABILIZED RICE BRAN
FLOUR MILL
FLOURS
STARCH PLT.
STARCHES
FERMENTATION PLANT
TANNIN
STABILIZED OIL
GLYCERIN
ETHYL ALCOHOL
CANVAS
SODIUM CARB
SODIUM SULPHATE
QUICK LIME
CHLOROSULPHONIC ACID

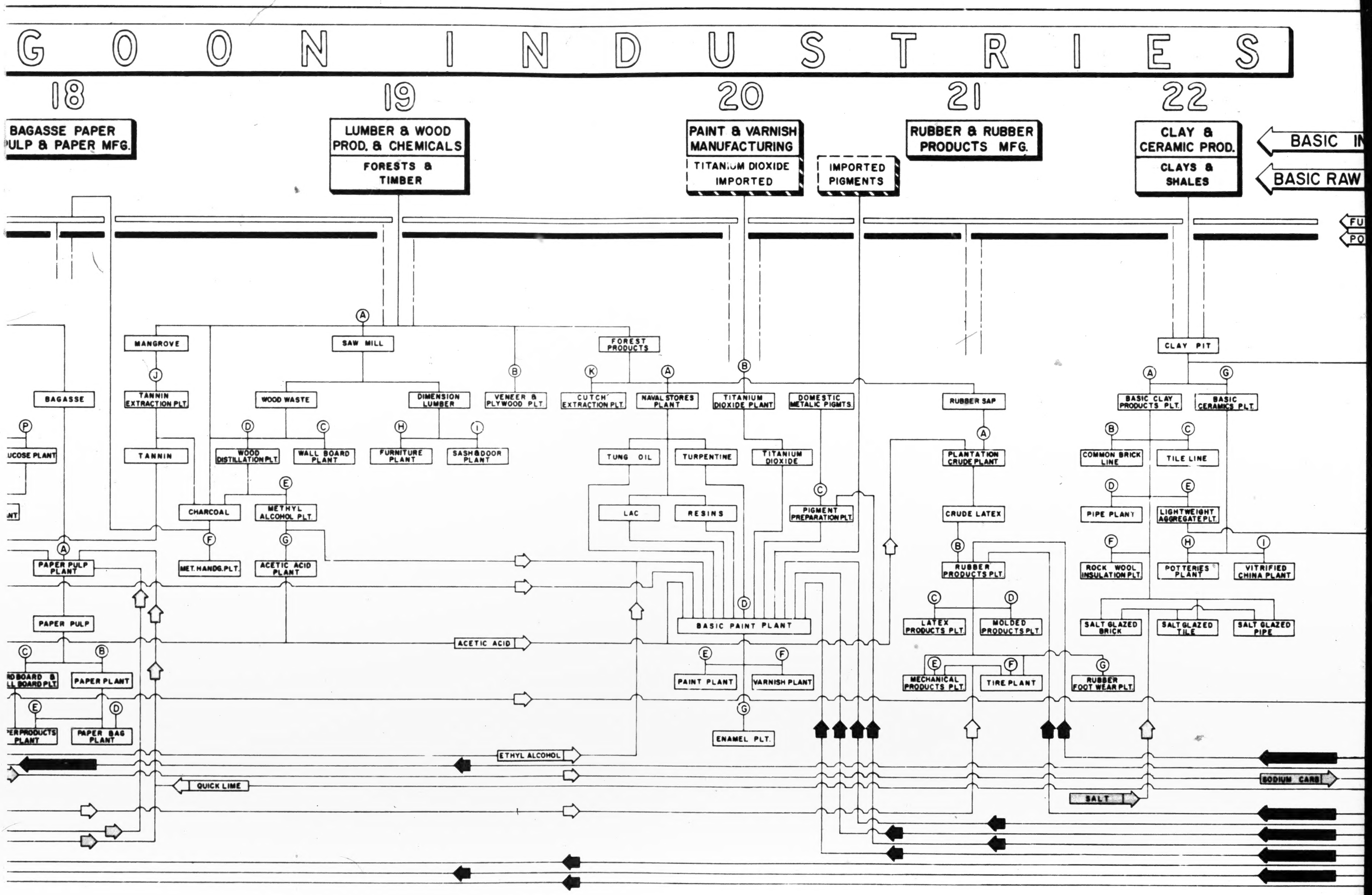
MINISTRY OF NATIONAL PLANNING

PROJECTED INDUSTRIAL DEVELOPMENT OF BURMA

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P. DATE PLATE
CK. BY C.M.C. MAY 1953 NO. 2 OF 5


R A N G O O
17
18
SUGAR & SUGAR CHEMICAL PROD.
SUGAR CANE
BAGASSE PAPER PULP & PAPER MFG.
A
PLANTATION MILL
BROWN SUGAR
B
SUGAR REFINED
BAGASSE
MANGROVE
J
TANNIN EXTRACTION PLT.
WOOD
P
D
MOLASSES
SYRUPS
REFINED WHITE SUGAR
GLUCOSE PLANT
TANNIN
WOOD DISTILLATION PLT.
FERMENTATION PLT.
C
E
Q
ETHYL ALCOHOL PLANT
CITRIC ACID PLANT
MEDICINAL GLUCOSE PLANT
CHARCOAL
TANNIN
O
A
F
F
ABSOLUTE ALCOHOL PLT.
FERMENTATION PLANT
SOFT DRINK PLANT
PAPER PULP PLANT
MET. HANDG. PLT.
STABILIZED OILS
G
J
ACETAL DEHYDE PLANT
ACETIC ACID PLANT
PAPER PULP
H
K
L
C
B
(NIACIN)
NICOTINIC ACID PLT.
CHLORO ACETIC ACID PLT.
ETHYL ACETATE PLANT
CARD BOARD & WALL BOARD PLT.
PAPER PLANT
GLYCERIN
I
M
E
D
(INH)
ISONICOTINIC ACID HYDROZIDE PLT.
ACETANILIDE PLANT
PAPER PRODUCTS PLANT
PAPER BAG PLANT
ETHYL ALCOHOL
N
SULFA INTERMEDIATE
QUICK LIME
CANVAS
SODIUM CARB
SODIUM SULP
QUICK LIME
CHLOROSULPHONIC ACID

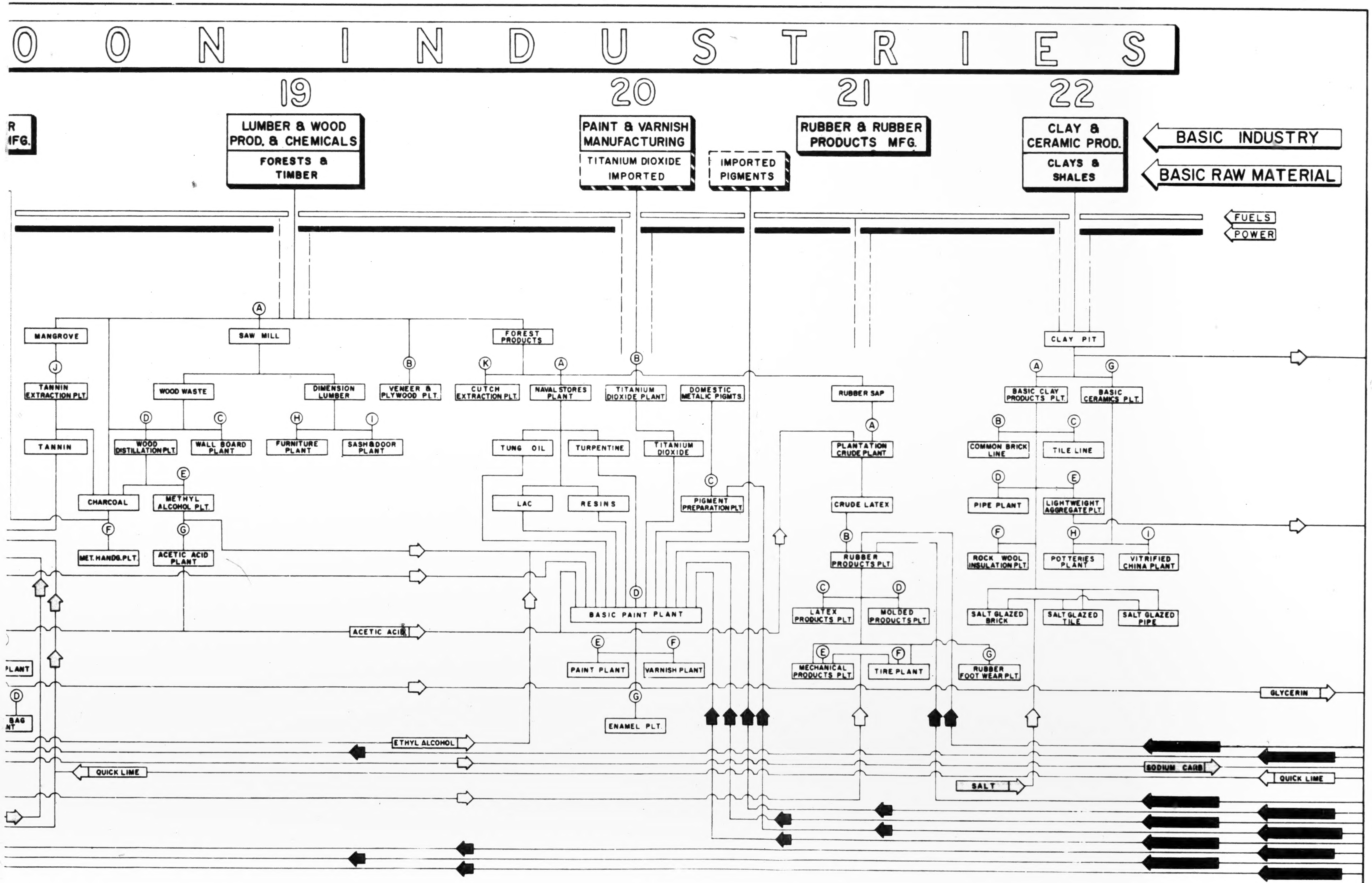

GOON INDUSTRIES
18
BAGASSE PAPER
ULP & PAPER MFG.
19
LUMBER & WOOD PROD. & CHEMICALS
FORESTS & TIMBER
20
PAINT & VARNISH MANUFACTURING
TITANIUM DIOXIDE IMPORTED
IMPORTED PIGMENTS
21
RUBBER & RUBBER PRODUCTS MFG.
22
CLAY & CERAMIC PROD.
CLAYS & SHALES
BASIC IN
BASIC RAW
FU
PO
BAGASSE
P
UCOSE PLANT
NT
A
PAPER PULP PLANT
PAPER PULP
C
RD BOARD & LL BOARD PLT
B
PAPER PLANT
E
PERPRODUCTS PLANT
D
PAPER BAG PLANT
MANGROVE
J
TANNIN EXTRACTION PLT
TANNIN
A
SAW MILL
WOOD WASTE
D
WOOD DISTILLATION PLT
C
WALL BOARD PLANT
DIMENSION LUMBER
H
FURNITURE PLANT
I
SASH & DOOR PLANT
CHARCOAL
F
MET. HANDG. PLT.
E
METHYL ALCOHOL PLT
G
ACETIC ACID PLANT
B
VENEER & PLYWOOD PLT
FOREST PRODUCTS
K
CUTCH EXTRACTION PLT
A
NAVAL STORES PLANT
TUNG OIL
TURPENTINE
LAC
RESINS
B
TITANIUM DIOXIDE PLANT
TITANIUM DIOXIDE
DOMESTIC METALIC PIGMTS
C
PIGMENT PREPARATION PLT
D
BASIC PAINT PLANT
E
PAINT PLANT
F
VARNISH PLANT
G
ENAMEL PLT.
RUBBER SAP
A
PLANTATION CRUDE PLANT
CRUDE LATEX
B
RUBBER PRODUCTS PLT
C
LATEX PRODUCTS PLT
D
MOLDED PRODUCTS PLT
E
MECHANICAL PRODUCTS PLT
F
TIRE PLANT
G
RUBBER FOOT WEAR PLT
CLAY PIT
A
BASIC CLAY PRODUCTS PLT
G
BASIC CERAMICS PLT
B
COMMON BRICK LINE
C
TILE LINE
D
PIPE PLANT
E
LIGHTWEIGHT AGGREGATE PLT
F
ROCK WOOL INSULATION PLT
H
POTTERIES PLANT
I
VITRIFIED CHINA PLANT
SALT GLAZED BRICK
SALT GLAZED TILE
SALT GLAZED PIPE
ACETIC ACID
ETHYL ALCOHOL
QUICK LIME
SODIUM CARB
SALT

MINISTRY OF NATIONA

PROJECTED IND
DEVELOPM
OF BURN

KNAPPEN TIPPETTS ABBETT
NEW YORK

DR. BY E.J.P.　DATE
CK. BY C.M.C.　MAY 1953

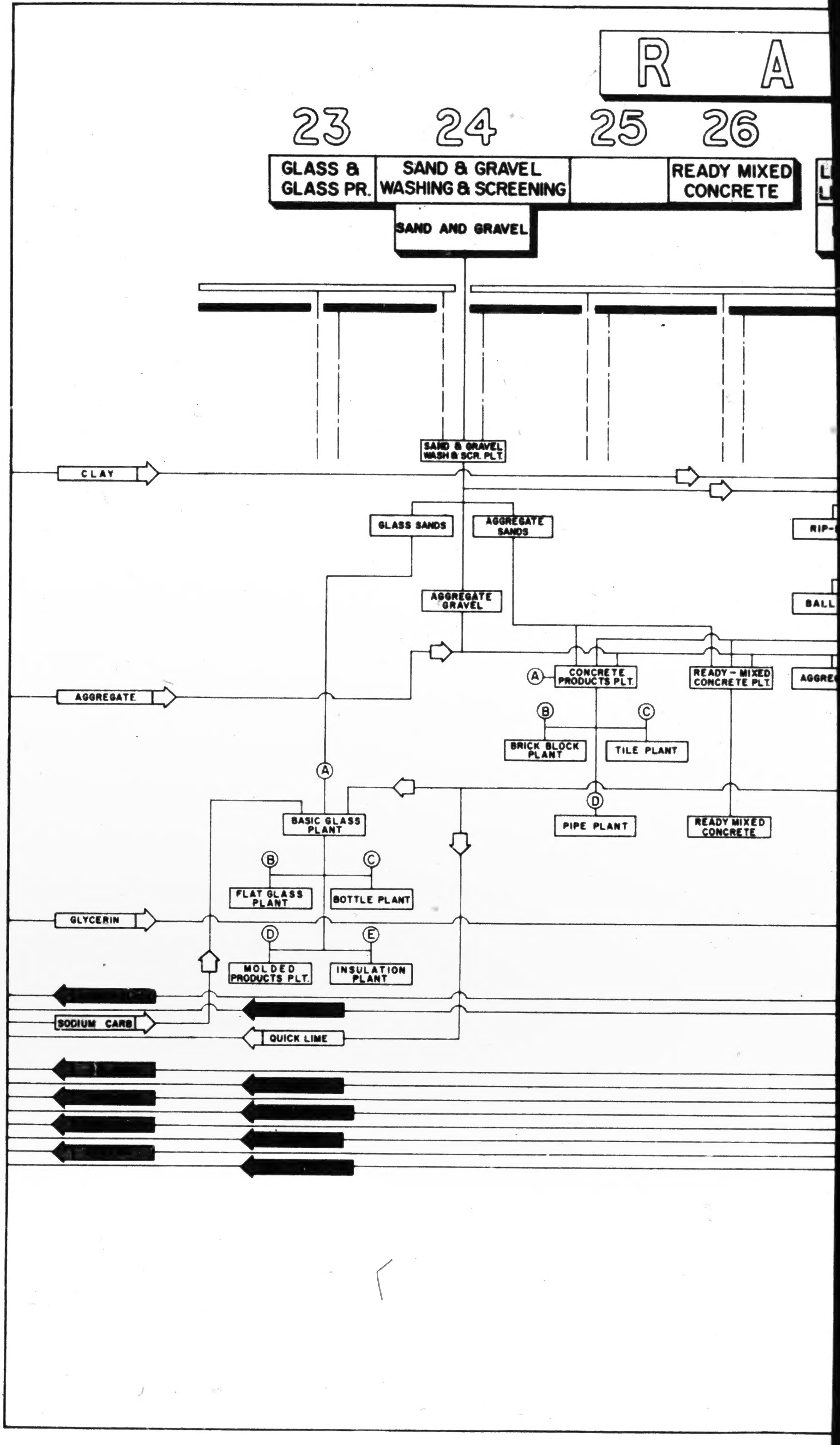

OON INDUSTRIES
19
20
21
22
R
IFG.
LUMBER & WOOD PROD. & CHEMICALS
FORESTS & TIMBER
PAINT & VARNISH MANUFACTURING
TITANIUM DIOXIDE IMPORTED
IMPORTED PIGMENTS
RUBBER & RUBBER PRODUCTS MFG.
CLAY & CERAMIC PROD.
CLAYS & SHALES
BASIC INDUSTRY
BASIC RAW MATERIAL
FUELS
POWER
A
MANGROVE
SAW MILL
B
FOREST PRODUCTS
J
TANNIN EXTRACTION PLT.
WOOD WASTE
DIMENSION LUMBER
VENEER & PLYWOOD PLT.
K
CUTCH EXTRACTION PLT.
A
NAVAL STORES PLANT
B
TITANIUM DIOXIDE PLANT
DOMESTIC METALIC PIGMTS.
D
C
H
I
TANNIN
WOOD DISTILLATION PLT.
WALL BOARD PLANT
FURNITURE PLANT
SASH & DOOR PLANT
TUNG OIL
TURPENTINE
TITANIUM DIOXIDE
E
CHARCOAL
METHYL ALCOHOL PLT.
LAC
RESINS
C
PIGMENT PREPARATION PLT.
F
G
MET. HANDG. PLT.
ACETIC ACID PLANT
D
BASIC PAINT PLANT
ACETIC ACID
PLANT
E
F
PAINT PLANT
VARNISH PLANT
D
BAG
NT
G
ENAMEL PLT.
ETHYL ALCOHOL
QUICK LIME
RUBBER SAP
A
PLANTATION CRUDE PLANT
CRUDE LATEX
B
RUBBER PRODUCTS PLT.
C
D
LATEX PRODUCTS PLT.
MOLDED PRODUCTS PLT.
E
F
G
MECHANICAL PRODUCTS PLT.
TIRE PLANT
RUBBER FOOT WEAR PLT.
CLAY PIT
A
G
BASIC CLAY PRODUCTS PLT.
BASIC CERAMICS PLT.
B
C
COMMON BRICK LINE
TILE LINE
D
E
PIPE PLANT
LIGHTWEIGHT AGGREGATE PLT.
F
H
I
ROCK WOOL INSULATION PLT.
POTTERIES PLANT
VITRIFIED CHINA PLANT
SALT GLAZED BRICK
SALT GLAZED TILE
SALT GLAZED PIPE
GLYCERIN
SODIUM CARB
QUICK LIME
SALT

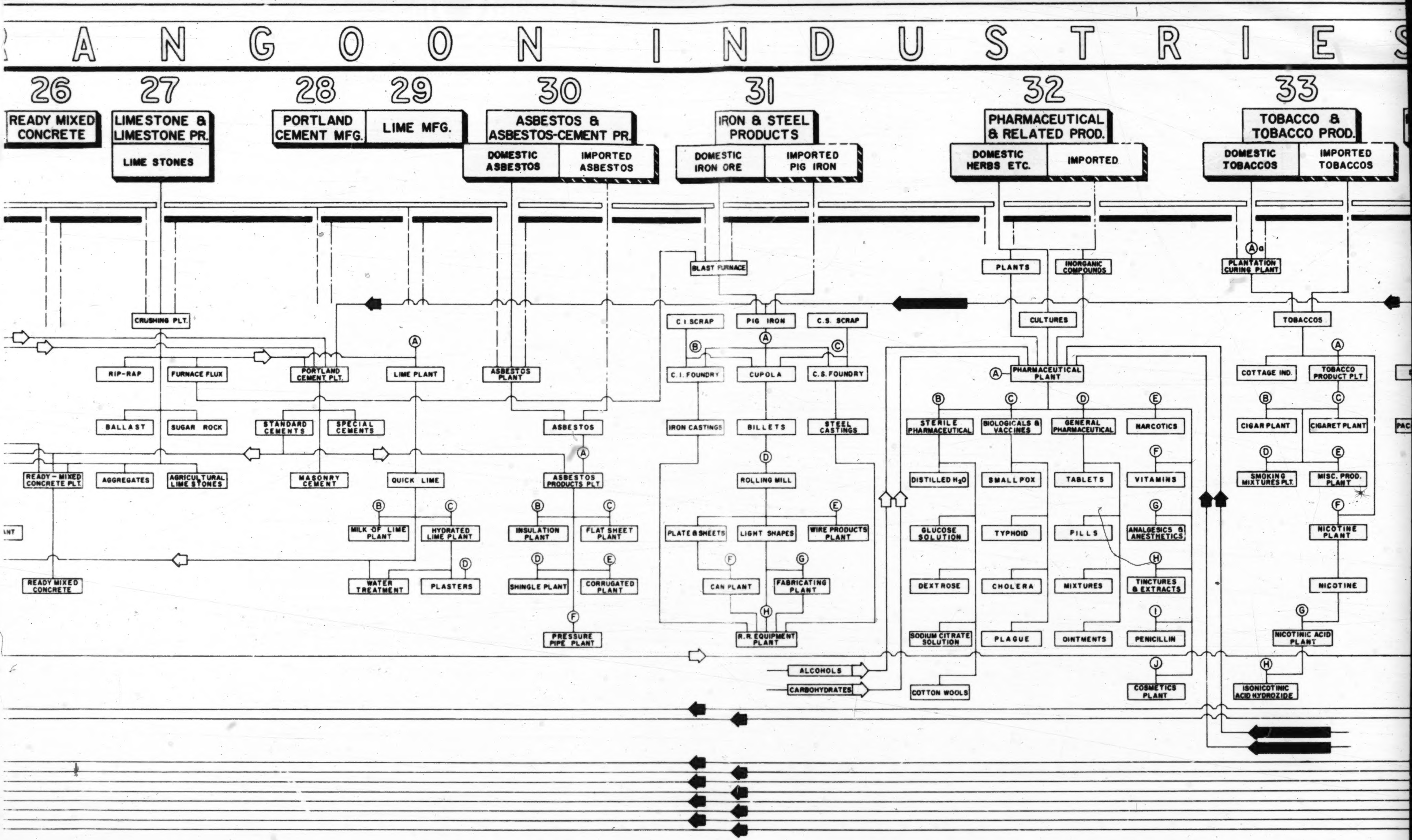
MINISTRY OF NATIONAL PLANNING

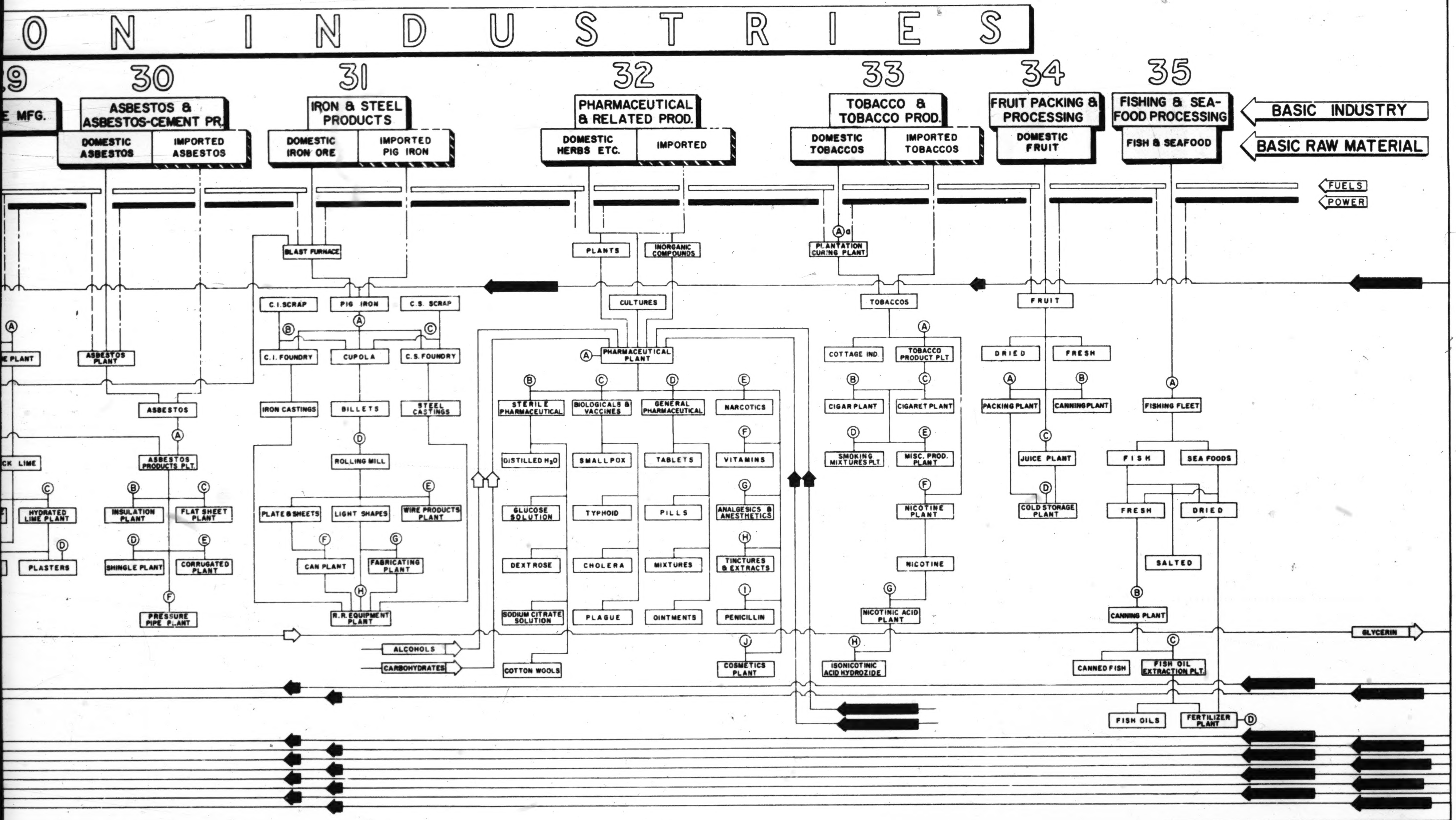
PROJECTED INDUSTRIAL DEVELOPMENT OF BURMA

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR BY E.J.P
CK. BY C.M.C.
DATE MAY 1953
PLATE NO. 3 OF 5


R A
23
24
25
26
GLASS & GLASS PR.
SAND & GRAVEL WASHING & SCREENING
READY MIXED CONCRETE
SAND AND GRAVEL
SAND & GRAVEL WASH & SCR. PLT.
CLAY
GLASS SANDS
AGGREGATE SANDS
RIP-
AGGREGATE GRAVEL
BALL
AGGREGATE
A
CONCRETE PRODUCTS PLT.
READY - MIXED CONCRETE PLT.
AGGRE
B
C
BRICK BLOCK PLANT
TILE PLANT
A
D
PIPE PLANT
READY MIXED CONCRETE
BASIC GLASS PLANT
B
C
FLAT GLASS PLANT
BOTTLE PLANT
GLYCERIN
D
E
MOLDED PRODUCTS PLT.
INSULATION PLANT
SODIUM CARB
QUICK LIME


RANGOON INDUSTRIES
26
READY MIXED CONCRETE
27
LIMESTONE & LIMESTONE PR.
LIME STONES
28
PORTLAND CEMENT MFG.
29
LIME MFG.
30
ASBESTOS & ASBESTOS-CEMENT PR.
DOMESTIC ASBESTOS
IMPORTED ASBESTOS
31
IRON & STEEL PRODUCTS
DOMESTIC IRON ORE
IMPORTED PIG IRON
32
PHARMACEUTICAL & RELATED PROD.
DOMESTIC HERBS ETC.
IMPORTED
33
TOBACCO & TOBACCO PROD.
DOMESTIC TOBACCOS
IMPORTED TOBACCOS
CRUSHING PLT.
RIP-RAP
FURNACE FLUX
BALLAST
SUGAR ROCK
AGGREGATES
AGRICULTURAL LIME STONES
READY-MIXED CONCRETE PLT.
ANT
READY MIXED CONCRETE
PORTLAND CEMENT PLT.
STANDARD CEMENTS
SPECIAL CEMENTS
MASONRY CEMENT
A
LIME PLANT
QUICK LIME
B
MILK OF LIME PLANT
C
HYDRATED LIME PLANT
D
PLASTERS
WATER TREATMENT
ASBESTOS PLANT
ASBESTOS
A
ASBESTOS PRODUCTS PLT
B
INSULATION PLANT
C
FLAT SHEET PLANT
D
SHINGLE PLANT
E
CORRUGATED PLANT
F
PRESSURE PIPE PLANT
BLAST FURNACE
C.I. SCRAP
PIG IRON
C.S. SCRAP
A
B
C
C.I. FOUNDRY
CUPOLA
C.S. FOUNDRY
IRON CASTINGS
BILLETS
STEEL CASTINGS
D
ROLLING MILL
E
PLATE & SHEETS
LIGHT SHAPES
WIRE PRODUCTS PLANT
F
G
CAN PLANT
FABRICATING PLANT
H
R.R. EQUIPMENT PLANT
ALCOHOLS
CARBOHYDRATES
PLANTS
INORGANIC COMPOUNDS
CULTURES
A
PHARMACEUTICAL PLANT
B
STERILE PHARMACEUTICAL
C
BIOLOGICALS & VACCINES
D
GENERAL PHARMACEUTICAL
E
NARCOTICS
DISTILLED H_2O
SMALLPOX
TABLETS
F
VITAMINS
GLUCOSE SOLUTION
TYPHOID
PILLS
G
ANALGESICS & ANESTHETICS
DEXTROSE
CHOLERA
MIXTURES
H
TINCTURES & EXTRACTS
SODIUM CITRATE SOLUTION
PLAGUE
OINTMENTS
I
PENICILLIN
COTTON WOOLS
J
COSMETICS PLANT
A a
PLANTATION CURING PLANT
TOBACCOS
COTTAGE IND.
A
TOBACCO PRODUCT PLT
B
CIGAR PLANT
C
CIGARET PLANT
PAC
D
SMOKING MIXTURES PLT.
E
MISC. PROD. PLANT
F
NICOTINE PLANT
NICOTINE
G
NICOTINIC ACID PLANT
H
ISONICOTINIC ACID HYDROZIDE


ON INDUSTRIES
29
E MFG.
30
ASBESTOS & ASBESTOS-CEMENT PR.
DOMESTIC ASBESTOS
IMPORTED ASBESTOS
31
IRON & STEEL PRODUCTS
DOMESTIC IRON ORE
IMPORTED PIG IRON
32
PHARMACEUTICAL & RELATED PROD.
DOMESTIC HERBS ETC.
IMPORTED
33
TOBACCO & TOBACCO PROD.
DOMESTIC TOBACCOS
IMPORTED TOBACCOS
34
FRUIT PACKING & PROCESSING
DOMESTIC FRUIT
35
FISHING & SEA-FOOD PROCESSING
FISH & SEAFOOD
BASIC INDUSTRY
BASIC RAW MATERIAL
FUELS
POWER
A
E PLANT
CK LIME
C
HYDRATED LIME PLANT
D
PLASTERS
ASBESTOS PLANT
ASBESTOS
A
ASBESTOS PRODUCTS PLT.
B
INSULATION PLANT
C
FLAT SHEET PLANT
D
SHINGLE PLANT
E
CORRUGATED PLANT
F
PRESSURE PIPE PLANT
BLAST FURNACE
C.I. SCRAP
PIG IRON
C.S. SCRAP
A
B
C
C.I. FOUNDRY
CUPOLA
C.S. FOUNDRY
IRON CASTINGS
BILLETS
STEEL CASTINGS
D
ROLLING MILL
E
PLATE & SHEETS
LIGHT SHAPES
WIRE PRODUCTS PLANT
F
G
CAN PLANT
FABRICATING PLANT
H
R.R. EQUIPMENT PLANT
ALCOHOLS
CARBOHYDRATES
PLANTS
INORGANIC COMPOUNDS
CULTURES
A
PHARMACEUTICAL PLANT
B
C
D
E
STERILE PHARMACEUTICAL
BIOLOGICALS & VACCINES
GENERAL PHARMACEUTICAL
NARCOTICS
DISTILLED H_2O
SMALLPOX
TABLETS
F
VITAMINS
GLUCOSE SOLUTION
TYPHOID
PILLS
G
ANALGESICS & ANESTHETICS
DEXTROSE
CHOLERA
MIXTURES
H
TINCTURES & EXTRACTS
SODIUM CITRATE SOLUTION
PLAGUE
OINTMENTS
I
PENICILLIN
J
COSMETICS PLANT
COTTON WOOLS
A a
PLANTATION CURING PLANT
TOBACCOS
A
COTTAGE IND.
TOBACCO PRODUCT PLT
B
C
CIGAR PLANT
CIGARET PLANT
D
E
SMOKING MIXTURES PLT.
MISC. PROD. PLANT
F
NICOTINE PLANT
NICOTINE
G
NICOTINIC ACID PLANT
H
ISONICOTINIC ACID HYDROZIDE
FRUIT
DRIED
FRESH
A
B
PACKING PLANT
CANNING PLANT
C
JUICE PLANT
D
COLD STORAGE PLANT
A
FISHING FLEET
FISH
SEA FOODS
FRESH
DRIED
SALTED
B
CANNING PLANT
C
CANNED FISH
FISH OIL EXTRACTION PLT.
FISH OILS
FERTILIZER PLANT
D
GLYCERIN

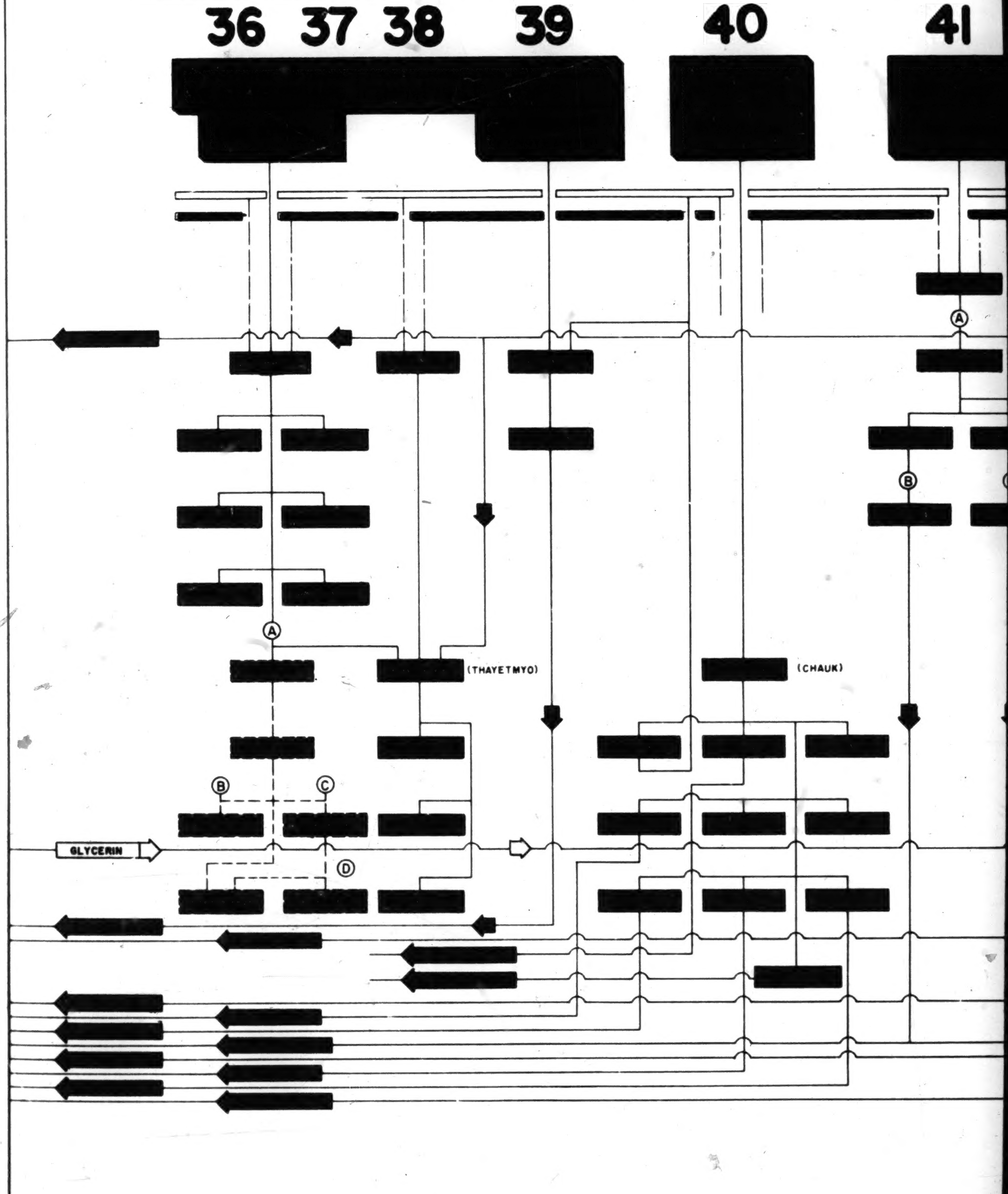
MINISTRY OF NATIONAL PLANNING

PROJECTED INDUSTRIAL DEVELOPMENT OF BURMA

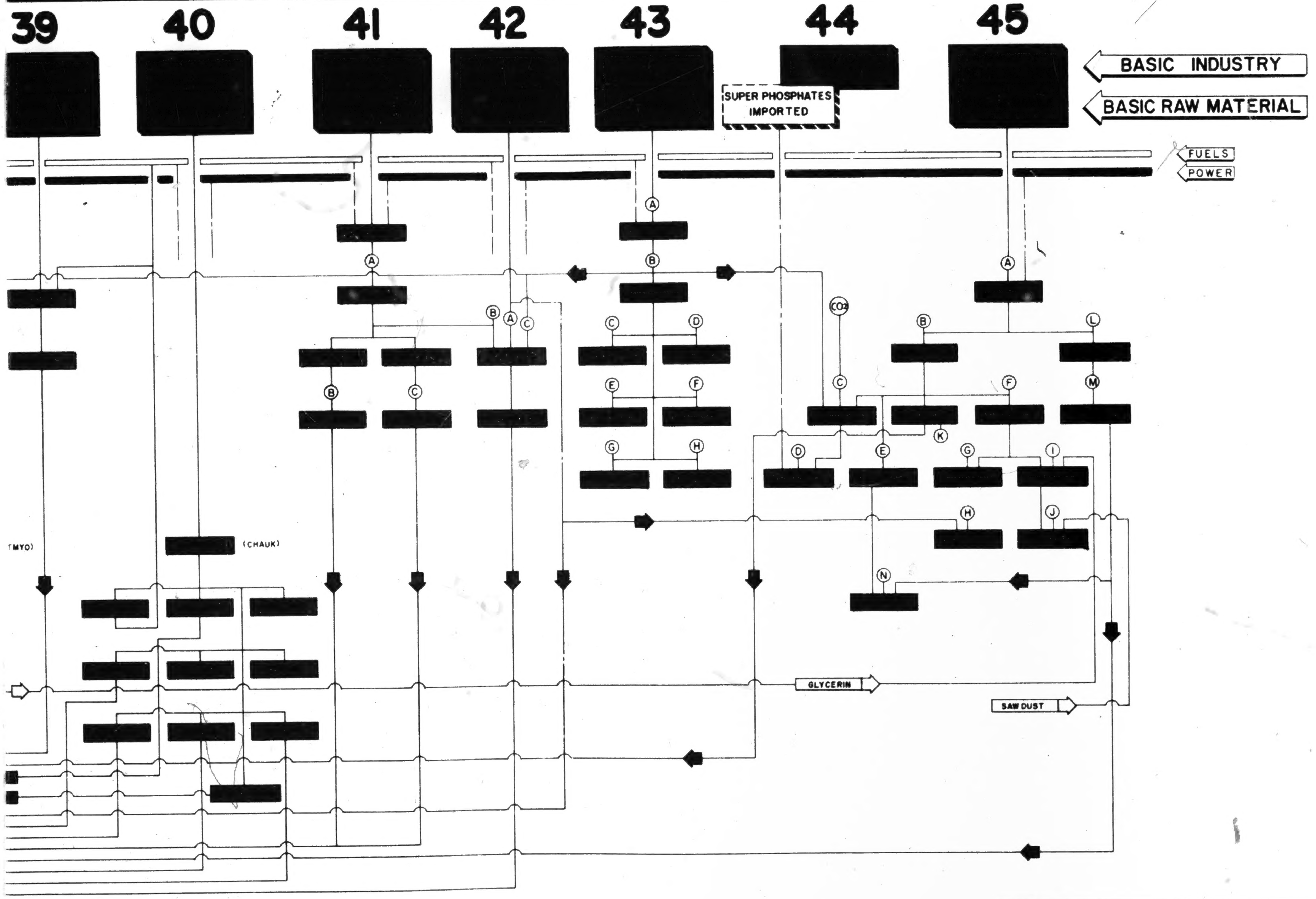
KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P.	DATE	PLATE
CK. BY C.M.C.	MAY 1953	NO. 4 OF 5

MYINGYAN INDUS


36
37
38
39
40
41
A
B
C
D
(THAYETMYO)
(CHAUK)
GLYCERIN

YAN INDUSTRIAL DISTRICT


39
40
41
42
43
44
45
BASIC INDUSTRY
BASIC RAW MATERIAL
SUPER PHOSPHATES IMPORTED
FUELS
POWER
A
B
C
D
E
F
G
H
I
J
K
L
M
N
CO2
MYO)
(CHAUK)
GLYCERIN
SAW DUST

MINISTRY OF NATIONAL PLANNING

PROJECTED INDUSTRIAL DEVELOPMENT OF BURMA

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E. J. P.	DATE	PLATE
CK. BY C. M. C.	MAY 1953	NO. 5 OF 5

commercial importance is found a study should be made of the two methods of extraction mentioned above and a decision made based on economy. Sodium sulphate is available in many countries, including India and Japan, and is fairly cheap if bought and shipped in large quantities. The paper factory's annual requirement will be about 3,000 tons, and, since the factory will be the only large consumer in the immediate future, it is recommended that the salt be imported. At current prices for large shipments the annual expenditure will be about K 1,80,000.

(2) Limestone

The operation of the pulp and paper factory requires the use of a considerable quantity of quicklime, which should be made in a lime plant adjacent to the paper factory. A high calcium limestone is required for conversion into quicklime. The rock formation in the Akyab area is entirely sandstone. Consequently limestone must be brought in. Limestone of good quality was reported on Ramree Island, on Cheduba Island, on Ye Island, and near Sandoway, on the mainland.

(a) **Ramree island deposits.** The Ramree island deposits are all located in the region of the city of Ramree and south. Security restrictions made it impossible to inspect these deposits. The deposits were reported as being extensive, that they were being worked for the manufacture of quicklime. It was reported that all limestone quarried could be transported by country boats to Doratha, the port of call for coastal vessels. A sample of the burned lime was obtained and analysed by the Burma Research Laboratories Ltd., of Rangoon. The analysis follows:

Calcium Carbonate	$CaCO_3$	64·36%
Calcium Oxide	CaO	15·04%
Aluminum Oxide	Al_2O_3	7·92%
Iron		Trace
Silica		0·36%
Moisture		12·32%
		100·00%

The limestone from which this lime was made should be satisfactory for the paper factory use.

(b) **Cheduba island deposits.** An inspection of some of the deposits on Cheduba Island was made, and samples of two deposits were obtained. The lack of transport on this island, and limited security conditions, prevented inspection of deposits farther inland. One small limestone deposit was found about four and one-half miles inland, to the southwest of the town of Cheduba, near the village of Budaunggwe. The vertical height of the deposit was approximately 40 ft., it was oval in shape with a long axis about 100 ft. and the short axis about 50 ft. The extent of the formation below ground was not determined. Samples of this were analyzed as follows:

Calcium Carbonate	$CaCO_3$	67·22%
Calcium Oxide	CaO	30·85%
Iron Oxide	Fe_2O_3	0·47%
Silica	SiO_3	0·47%
Moisture		0·99%
		100·00%

This is a very good limestone, but the visible deposit is too small to support the operation of the paper factory.

A second deposit which appeared to be coral was inspected. This deposit was much larger, being at least ¼ mile long by ⅛ mile wide, extended about 20 ft. above the ground surface. This deposit was being worked for building stone. The rock was soft and porous, and was easily cut out with a wood saw. Samples of this material were analyzed as follows:

Calcium Carbonate	$CaCO_3$	95·72%
Calcium Oxide	CaO	0·72%
Iron Oxide	Fe_2O_3	0·52%
Silica	SiO_3	1·29%
Moisture		1·75%
		100·00%

This would make excellent lime, and if the deposit proved large enough, would be satisfactory as a limestone source. Larger deposits farther inland were reported, but could not be verified.

It is believed that there is enough limestone on this island of suitable quality, to support the operation of the paper factory. Roads must be built to bring any limestone to the port of Cheduba. The harbor at Cheduba is shallow but would permit the operation of barges of a minimum draft of eight feet at high tide.

The deposits reported on Ye Island, southeast of Cheduba Island, might be more accessible. This is a smaller island, so any inland hauling would be minimized. Also, the water is deeper. These deposits were not inspected, but are believed to be of the same formation as the limestone on Cheduba Island. The distance from Cheduba to the paper factory site would be about 125 miles.

The Sandoway deposits were not inspected, but are believed to be of the same character as the island formations.

Lime for use for water treatment, for plaster, and for mortar, in the Arakan area, could be manufactured from any of the limestones found. The lime plant at the paper factory should include some margin of production for these purposes.

Aggregates for the Akyab area could be produced cheaper from dolomite shingle available between 30 and 40 miles north of Akyab on the Kaladan River.

An additional small amount of limestone will be required for the manufacture of calcium carbide, Project 7. This would come from the same source. Agricultural lime is another possible use if the cultivated land is sour, as it may well be in such a predominantly sandstone area.

An initial production of about 2,400 long tons of limestone per year will be required for producing the 1,500 long tons of quicklime needed by the pulp and paper factory. Other uses should at least double this capacity. This production of 16–20 long tons a day will require only a simple plant. This should be located at the limestone deposit. A small crushing and screening plant of this size, with quarry equipment and trucks will cost about K5,00,000 for the equipment alone. The production cost should not exceed K7.00 per long ton, f.o.b. plant. The cost of delivery from the quarry site to the factory is estimated at K33.00 per long ton, which would make the delivered cost, f.o.b. paper factory, K40.00 per long ton.

A special vessel will probably have to be constructed to carry the salt and the limestone from the production points to the paper factory.

(3) Lime

Because there is no limestone in the Kyaukpyu–Akyab area, no quicklime or hydrated lime is manufactured. The nearest known point of manufacture is near Ramree, on Ramree Island. There is a subnormal use of lime in this area for plaster and for mortar for brick. None is known to be used for water treatment or for sanitary purposes. The pulp and paper factory to be erected near Ponnagyun will require about 1,500 long tons of quicklime per year, or five long tons per day. It is estimated that the other market for quicklime and for hydrated lime will total from five to ten long tons per day.

While it is possible to ship in lime for use in this area, as is now done, the freight on such shipments makes the delivered cost too high for any industrial use at least. It is certain that even a small lime plant could produce quicklime or hydrated lime at a lower delivered price than that of any lime shipped in.

The location of any lime plant in the Arakan district is dependent upon the cost of transporting the raw material and fuel to the plant compared to the cost of transporting the finished lime to the principal market. Power and labor must also influence the selection of a plant site.

The manufacture of quicklime consists of calcining a high calcium carbonate limestone, so that calcium oxide is produced. The burning process drives off a large quantity of carbon dioxide gas and some water. It thus requires almost two tons of limestone to produce one ton of quicklime. If the quicklime is hydrated, which is done by adding water until the quicklime is slaked, almost the original weight of the limestone is regained. Thus transportation makes little difference in delivered cost if hydrated lime is to be made, and the lime plant can be located either at the limestone deposit or at the principal market.

Quicklime will hydrate naturally to some degree in humid climates. It may well be better to manufacture hydrated lime at Ponnagyun as the pulp and paper factory will preferably use quicklime. The lime plant could then supply the paper plant with fresh quicklime, and hydrate the balance of the production. Some economies would result from such a location as the technical staff of the paper plant, its managerial staff, its shops, power and other facilities could be utilized in common, thus reducing the cost of both operations.

Limestone as concrete aggregate could also be made available if the limestone were to be produced and crushed at the limestone quarry. Barges will be required for transporting salt to Ponnagyun. These could be used to transport the limestone as well. Fuel and power and labor would be more available at Ponnagyun than at the quarry site. It is therefore recommended that a lime plant of 15 to 25 long tons per day of quicklime be constructed adjacent to the paper factory, if found to be practical.

A lime plant of this capacity is estimated to cost approximately as follows:

	Kyats
Basic Machinery and Equipment	9,44,000
Electric Motors and Controls	47,200
Electrical Distribution	94,400
Laboratory Equipment	47,200
Shops and Tools (partial)	94,400
Office Equipment (partial)	25,000
Stores Equipment (partial)	25,000
Water, Air, Sewer, and Process Pipe Lines	94,400
Fuel Oil Storage and Pipe Lines	94,400
Automobile Equipment	94,400
	15,60,400
Building Materials	3,87,600
Ocean Freight and Insurance	1,55,000
Engineering, Erection and Construction	7,75,000

	Kyats
Construction Overhead	4,72,000
Contingencies	4,72,000
Total less Real Estate	38,22,000
Real Estate	1,90,000
Total Plant Cost	40,12,000
Working Capital	4,72,000
Total Capital Required	44,84,000

The estimate does not include cost of limestone quarry equipment or of barges. The total cost may be divided between local currency and foreign exchange, as follows:

Local Currency	K15,40,000
Foreign Exchange	K29,44,000
	K44,84,000

It will take about 18 months to complete a lime plant of this capacity, dating from the time engineering services are retained.

The first-year expenditures will consist of acquiring a plant site, grading it, making, a preliminary report drawing up specifications, field engineering, foundation construction work, and initial payments on machinery and materials.

These are estimated to total:

Local Currency	K 6,00,000
Foreign Exchange	K11,00,000
	K17,00,000

Because such a lime plant should be under the same ownership and top management as the pulp and paper factory, it should be financed in the same manner. The two plants will probably be either wholly GUB owned corporations, or owned jointly by GUB and private interests. If a wholly GUB owned corporation, it would be financed by a 100% capital loan made to the corporation by the GUB and secured by the assets of the lime plant corporation. Such a loan would be repaid out of earnings in equal annual installments over the number of years corresponding to the estimated useful life of the machinery and structures. The loan would bear compound interest at the rate of 4% for all local currency advanced, and at 5% for all foreign exchange funds required. In this case a weighted average useful life of the machinery, equipment and buildings has been estimated at 25 years.

The amount of the annual payments required to recover 100% of the capital loaned, including interest, is determined as follows:

	Factor	*Annual Payment*
Local Currency K15,40,000	·06401	K 98,575
Foreign Exchange K29,44,000	·07095	K2,08,875
Total per year		K3,07,450

This total amount should be charged against production costs on a per ton basis.

No depreciation, as such, should be charged into costs, as it is not intended to establish a capital reserve. Therefore any new capital required would have to be obtained and repaid in the same manner as the original loan. All such wholly GUB owned corporations should be operated as tax free, non-profit units which would also be exempt from the payment of import duties on machinery, repair parts, or supplies brought into Burma.

If the corporation became a joint venture operation, the financing and operation would be different, as private capital cannot invest unless allowed to make a fair profit with assurance that it can export dividends and capital recovered.

The operating cost, and cost of sales, of the proposed 25 long ton per day lime plant are estimated below. It is assumed that the limestone will cost K40.00 per long ton delivered at the plant site. About 10,000 long tons per year of limestone will be required.

Quicklime	*Annual Cost*	*Cost per Long Ton*
	K	K
Operating and Repair Labor	80,000	
Operating and Repair Supplies	50,000	
Limestone	4,00,000	
Fuel Oil	1,73,000	
Power	35,000	
General Works Expense	50,000	
Administration and OH Expense	50,000	
Insurance	20,000	
Amortization of Loan	2,07,450	
Total cost of Quicklime	10,65,450	
(Divisor 5,000 L.T./Year)		213.09
Hydrated Lime (4,000 L.T./Year)		
Quicklime (3,000 L.T.)	6,38,886	
Operating and Repair Labor	33,600	
Operating and Repair Supplies	20,000	
Power	20,000	
General Works and Expense	25,000	
Administration and OH Expense	25,000	
Insurance	10,000	
Amortization of Loan	1,00,000	
Total Cost of Hydrated Lime	8,72,486	218.12

The cost of paper sacks must be added to all costs except bulk sales. Imported paper bags will cost about K16.00 per long ton of lime. The pulp and paper plant will take delivery in bulk. The total costs would then be as follows:

1,500 L.T. Bulk Quicklime at K213.09 =	K 3,19,635
500 L.T. Sacked Quicklime at K229.09 =	K 1,14,545
4,000 L.T. Sacked Hydrated Lime at K234.12 =	K 9,36,480
Total Annual Cost	K13,70,660

The estimated costs are high compared to the current Rangoon selling prices for quicklime and hydrated lime, and are much higher than the estimated costs for a 100 L.T. per day plant for Rangoon, see Project 29. A very small plant such as the one proposed here cannot produce as cheaply as a larger plant. If the freight rate on lime from Rangoon to Akyab is less than the difference in the manufacturing costs of the two plants, then these products should be manufactured in Rangoon, or at some other point.

The freight rate on Portland cement from Rangoon to Akyab is K75.00 per long ton on the coastal vessels. Using the same freight rate for lime, lime manufactured in Rangoon, delivered at the paper plant, would cost K187.62 for quicklime, and K195.39 for hydrated lime. Both prices are below the estimated costs for the Ponnagyun plant.

The investment in the equipment for the limestone crushing plant, estimated to be K5,00,000 (see Project 1 (2)), would also be eliminated if the lime were manufactured in Rangoon. Also, initially, a single and larger plant at Rangoon would be a more stable investment if the Arakan market were to be included in its market territory.

An alternative method of supplying lime for the paper plant would be to install a vertical lime kiln plant, instead of the more efficient rotary kiln plant estimated here. The investment and manufacturing costs would be less, but the quality of the quicklime would not be as good. Considering all factors, it is recommended that the lime be manufactured in the larger plant in Rangoon as discussed in Project 29. This would be most beneficial for the nation as a whole.

If this freight rate can be reduced by 50% the lime from Rangoon could be delivered at Ponnagyun at about K15250 per long ton, in paper sacks. This is very little above the present Rangoon ex-warehouse price in jute sacks and containers.

(4) Salt

(a) The market. Implementation of an industrial expansion program even on a small scale will increase the demand for salt. Specifically, development of the paper mill, DDT, and other insecticide and repellent manufacturing facilities using chlorine and caustic soda as basic or auxiliary raw materials, will create a demand estimated at 45 tons of salt per day. The importation of only 13 tons of table salt in 1951-52 is indicative of the limited market for this grade. High grade, imported, refined table salt sells for about K3 per pound in the shops. This prices the commodity beyond the reach of most families.

Production costs of 64 salt factories in the Ganga district (Kyaukpyu) average about K90 per 1,000 viss (3,600 lbs.) and the annual outturn is about 1,800,000 lbs. The salt is shipped in bulk to Kyaukpyu, loading and freight being about K25 per 1,000 viss. GUB salt tax is K70 per 1,000 viss making the salt f.o.b. Kyaukpyu K185 per 1,000 viss. High freight rates prevent this salt from reaching Rangoon.

The proposed saltern development is specifically for the Ganga area although general arrangements and techniques are applicable to any sea water extraction operation regardless of location if suitable acreage is available. Some of the existing salterns may be consolidated or modified for higher production rates of purer material supplemented by new evaporating ponds and methods. One refinery may be built to handle the entire output of the existing and new ponds. Details of the project will be given in a project report bring prepared.

(b) Possibility of domestic production. All of the elements necessary for the low cost production of high grade salt are present in the country: the long coast line, a five months' dry season and plenty of marginal land. Salt making is an ancient art which modern technology has improved to the point where salt is one of the cheapest basic commodities in most countries. There are no proven mineral salt deposits in Burma, all salt traditionally being extracted from sea water or brine wells and springs. Salt factories are dispersed in several areas around the coast line and inland near salt springs and lakes.

Salt extraction from sea water has been practiced in Burma for many years. Before World War II, it was produced by private licensed operators under government supervision to insure quality. At present there is no GUB supervision except for the Salt Revenue Service which only collects a tax on all salt produced.

A project report is being prepared, detailing techniques and arrangements used in modern solar salterns for mass production of several grades of industrial and table salts. The scheme detailed in the project is for a 1,000-acre saltern, producing some 35,000 short tons of salt annually. However, efficient salterns can be in any reasonably sized units. A market analysis should therefore precede determination of size.

(c) **Economic feasibility**

(1) *Description of plant*

A modern solar production unit consists of nine or ten concentrating ponds and several crystallizing ponds. Concentrating ponds should be 15 times the area of crystallizing ponds.

There are several methods of building evaporating ponds. The best method to use in any given area depends upon construction equipment available and topography of the land. One pond found to be efficient is made by building levees (bunds) about four feet high on ground low enough that water may be admitted through floodgates at high tide without pumping. A small clamshell dredger, if available, is particularly suitable for this type of construction.

Concentration ponds may be irregular in size and shape and may, more or less, follow the contour of the land, but crystallizing ponds must be regular in size and shape with flat, well compacted bottoms sloping gently to allow the bittern to drain. Five to seven years are usually required to make a pond system impervious and to bring it to "maturity" after which it can produce up to 40 tons of salt per acre per year.

The production cycle is analogous to a large scale agricultural operation. The first concentrating pond is flooded after the rains have ceased long enough to permit the salt content of the water to return to normal (about 2·6% for the Bay of Bengal). As its density increases due to evaporation, the water in the ponds is moved slowly forward through the concentrating areas, gravity and natural tidal flow being used as much as possible. Algae and other microscopic vegetation cause the ponds to change color, gradually, from blue green through green and yellow to a deep rust. These growths have no deleterious effects.

After traversing the concentrating ponds and having attained a density of 24·6° to 24·0° Baume, the brine is pumped to crystallizing ponds where it is retained until it attains a density of 29°. Between 26·6 and 29°, the maximum quantity of high purity sodium chloride is deposited; most of the calcium sulphate (gypsum) having settled out when the brine had reached 25° in a previous pond. Magnesium salts do not precipitate in quantity before the brine reaches about 30°. Carbonates of calcium, magnesium and iron also are precipitated at about the same time as the calcium sulphate, i.e., at 25° Baume.

The entire crystallizing area is flooded to a depth of 14 inches with saturated brine from the final concentrating (pickle) pond. The level is kept constant until density reaches 29° after which the brine is allowed to flow to the bittern pond. The crystallizing pond is then refilled from the pickle pond, the cycle being repeated until harvesting begins. By using this method of controlled crystallization, about 15% of the sodium chloride is deposited as large crystals, about 98% pure, in a layer four to six inches deep in the crystallizing pond.

Approximately 8,600 gallons of Bay of Bengal water will yield one ton of sodium chloride and 300 gallons of bittern. The harvest from the crystallizing ponds is of sufficient purity for most industrial uses. For special industrial, commercial and human use, the salt is further refined by a series of washings and evaporations to desired purities.

(2) *Capital cost*

The estimated capital cost based on United States prices for a saltern producing 30,000 tons annually is:

Pond Construction	K 1,00,000
Buildings and Equipment	52,20,000
Construction and Erection	15,20,000
Ocean Freight and Insurance	3,15,000
Total	K71,55,000

The estimate foreign exchange expenditure is 60% or K42,93,000.

(3) *Production Cost per Ton:*

Harvest labor 300 men for 60 days at K5.00/day—K90,000	K 3.00
Process labor 50 men for 300 days at K5.00/day—K15,000	0.50
Fuel and Electric Power	40.00
Maintenance and Repairs	1.00
Fixed Charges	
Depreciation on 20 Year Life, Foreign Exchange	
Capital K42,93,000 at 8·02%—K 3,42,000	11.40
Depreciation on 20 Year Life-domestic Currency	
Capital K28,62,000 at 7·36%—K2,10,000	7.00
Total Production Cost	K62.90

Present production cost in Ganga factories is about K90 per 100 viss or K62 per ton. These costs are not exactly comparable, as Ganga salt is not refined.

Further, plant capital costs were based on United States prices. Equipment from soft currency sources may be cheaper. Production of 30 tons per acre per season was taken as a conservative figure, as yields up to 40 tons per acre per season are not unusual.

(d) Recommendations. In order that an adequate supply of salt be available when the consumer industries based upon this material are ready for operation, the following implementation program is recommended.

(1) Initiate an instruction program among present saltern operators for improvement of evaporating and crystallizing ponds.

(2) Design and construct a refining plant possibly on a cooperative basis between Government and individual producers.

(3) Enlarge existing salterns in the Ganga district either through existing private owners or by state enterprise.

(4) Further study the salt transport problem. Present transportation facilities preclude widespread distribution.

(5) Undertake geological surveys including drilling in inland areas to locate mineral salt veins evidenced by salt springs, wells and lakes from which salt has been extracted for many years. After location, methods of extraction and refining can be developed.

(5) Bamboo Pulp and Paper

(a) Market. Except for a small amount of hand-made paper, Burma imports all paper and paper product requirements. The four types of paper that comprise the bulk of imports are packing and wrapping, writing, printing and old newspapers used for wrapping merchandise in the smaller shops. Since the manufacture of newsprint is not contemplated it is not included in this report.

It is estimated that average annual consumption of the four types of paper under discussion is 7,000 tons. Burma's 1952–53 population is estimated at 18·99 million; the per capita consumption of the papers mentioned is estimated at 0·8 pounds. A population of 20·8 million is expected by 1960. On the basis of present per capita consumption this would bring annual paper requirement to some 7,600 tons.

It is difficult to estimate with any degree of accuracy an increase in consumption engendered by a rise in the standard of living and availability of a lower cost product. However, the history of paper consumption in most other countries shows a rise proportional to these factors. The increase for Burma is estimated at an additional 20% by 1960. This would result in an annual consumption of 9,100 tons.

Limitation of the types and grades of paper that can be produced from bamboo are technological. The range of possible papers is considerable and is dictated by the process used and by plant design. It is not possible, at present, to produce newsprint from bamboo competitively with the standard imported product made from soft woods. However, a well designed and operated process can produce high grade papers of several types from bamboo competitively.

In addition to domestic markets, export outlets for several grades of paper and pulp exist in some of the countries in the east with which Burma normally trades, India and Japan in particular. Both countries are potential customers for pulp. Japan now imports pulp from both dollar and sterling areas while India, which now produces only about 60% of her paper requirements, would probably become a customer for both pulp and paper. Markets, both domestic and export, are accessible through sea transport. Inland domestic distribution will be by truck and rail following usual channels.

(b) Possibility of domestic production. (1) A project report has been completed on a pulp and paper mill having an annual pulp capacity of 30,000 tons of which 10,000 tons will be converted to paper, the remaining 20,000 tons being available for export. The project report shows that a return of about 16% can be expected on an estimated investment of K6·0 crores of which about K4·1 crores will be in foreign exchange and K1·9 crores in domestic currency. The landed cost of imported papers is such that there is sufficient margin to make the operation attractive.

(2) The basic raw material grows in profusion in Burma. Chlorine and caustic soda, two of the principal chemicals, will be produced at the mill. Other necessary chemicals will be imported. The most attractive feature of establishing a pulp and paper industry in Burma is the vast amount of quickly regrowing (eight years) bamboo, a material that excels many other grasses and grain straws in pulping qualities and paper making characteristics. It is amenable to mechanical harvesting, the most efficient method for which constitutes a problem to be worked out in the course of project design.

The Saingdin Falls hydro development will provide a source of power. Fuel, either oil or coal, will be imported. With the exception of chemicals such as sodium sulphate, resin, alum and others in small amounts, and fuel, adequate resources are available economically within the country to support the operation.

(c) **Benefits.** The paper mill's contribution to the nation's welfare will be considerable. Employment at full capacity will reach about 3,500 persons including mill operators, forest workers and raftsmen. Of the total, about 1,500 will be full time workers and the remainder employed about seven months in the year cutting and rafting. The full impact on the economy of the vicinity in which it is located is, of course, difficult to evaluate. However, a pay roll approximating K50 lakhs annually in a predominantly agricultural region will undoubtedly go far to increase business, trading and the general welfare in the area.

(d) **Training requirement.** A technical training program featuring on-the-job training in paper mills abroad for operational workers and in the shops of equipment manufacturers has been submitted and is under consideration by the proper authorities for activation.

(e) **Management.** There are several ways by which over-all top management may be provided. If Government elects to form a joint venture with an existing manufacturer, management would be provided by the partner company. An alternative scheme would entail entire financing by Government and retaining management under contract from an operating firm, preferably on an incentive basis.

(f) **Economic feasibility.** The plant proposed is a modern high production mill using the sulphate process. A tentative site has been selected on the west bank of the Kaladan River about 13 miles north of Akyab. This location has the multiple advantage of being at the confluence of three water routes over which bamboo will be rafted, and of being on deep water. Water depth at plant dockside will accommodate ocean-going vessels which would eliminate the necessity for trans-shipment.

(g) **Production cost.** Production costs for purposes of this report have been departmentalized for simplicity into three divisions: wet pulp (for paper making in the mill), dried pulp (for export), and paper. Provisional production cost estimate per ton (2,240 lbs.) for 30,000 tons annually of wet (slush) pulp follows:

PRODUCTION EXPENSES

	Quantity per Ton of Pulp Tons	*Cost per Ton of Material. Kyats*	*Cost per Ton Pulp. Kyats*	
(*a*) Bamboo	3·0	35.00	105.00	
(*b*) Glauber's Salt	0·100	174.00	17.40	
(*c*) Lime	0·067	166.00	11.10	
(*d*) Caustic Soda	0·019	110.00	2.08	
(*e*) Chlorine	0·100	392.00	39.20	
(*f*) Coal for Process Steam	1·2	90.00	108.00	
(*g*) Labor	96 man hours	0.51	49.00	
(*h*) Administrative and Executive Expenses			15.00	
(*i*) Maintenance and Repairs			7.00	
Total			353.78	353.78
Fixed Charges				
(*j*) Depreciation on wet pulp plant at 15 year life [1]				
Foreign capital—K[illegible],51,40,000 at 9·634%—K33,80,000			101.00	
Domestic capital—K1,50,60,000 at 8·994%—K13,55,000			45.20	
(*k*) Local Taxes and Insurance—K5,02,000			16.70	
Total			162.90	162.90
Mill cost per ton of slush pulp				516.68

COST OF DRIED AND BALED PULP (KYATS)—
19,500 TONS ANNUALLY

Item	*Quantity per Ton Pulp*	*Cost per Ton of Material*	*Cost per Ton Pulp*	
Wet Pulp (brought forward)	1·0	516.68	516.68	
Labor	20 man hrs.	0.51	10.20	
Coal and Power	0·6 ton	90.00	54.00	
Administrative, Executive and Sales Cost			5.00	
Total			585.88	585.88
Fixed Charges				
Depreciation on pulp drying, baling, storage and handling equipment at 15 year life [2]				
Foreign Capital—K24,50,000 at 9·634%—K2,36,000			11.80	
Domestic Capital—K10,50,000 at 8·994%—K94,437			4.72	
Local Taxes and Insurance K35,00,000 at 1%—K35,000			1.75	
			18.27	18.27
Mill cost of dried and baled pulp				604.15

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[1] Depreciation is computed as a uniform annual installment necessary for capital recovery together with interest payable on capital investment. The interest rates are 5% for foreign and 4% for domestic capital.

[2] Computed on basis of 20,000 tons of slush pulp annually.

COST OF PAPER (KYATS)—10,000 TONS ANNUALLY

Item	*Quantity per Ton Paper*	*Cost per Ton of Material*	*Cost per Ton of Paper*	
Wet Pulp	1·05	516.68	541.00	
Resin	0·02	3000.00	60.00	
Soda Ash	0·005	584.00	2.92	
Alum	0·050	284.00	14.20	
Methyl Violet	0·033 lb.	89.50lb.	2.95	
Clay	0·120	182.00	21.90	
Coal for Process Steam and Power	1·25	90.00	113.00	
Labor	40 man hrs.	0.51 K/hr.	20.40	
Maintenance and Repairs			5.00	
Administrative, Executive and Sales Cost			5.00	
			786.37	
Fixed Charges				
Depreciation on paper making equipment at 15 year life				
Foreign Capital—K38,50,000 at 9·634%—K3,65,000			36.50	
Domestic Capital—K16,50,000 at 8·994%—K1,48,000			14.80	
Local Taxes and Insurance—K55,00,000 at 1·0%—K55,000			5.50	
			56.80	56.80
Mill cost per ton paper				843.17

(h) Earnings

(1) *Pulp*

The recent trend of pulp prices has been downward, but because the demand for paper continues strong throughout the world it is not expected that the wholesale prices for imported pulp will drop much below $165 per long ton (£59 or K785). Bamboo pulp, being a relatively new commodity on the world market, may bring a slightly lower price than that given above. Its mill selling price is estimated in this Report at $154 per long ton (£55 or K730).

The gross return from pulp sales would be as follows:

Selling price f.o.b. mill	K730 per ton
Production Cost	K605 per ton
Gross Profit	K125

The annual gross profit would be:

K125 × 19,500 tons = K24,40,000

(2) *Paper*

Paper production is intended for internal consumption and only the surplus would be available for export. Imported paper has been costly in Burma and consequently its consumption has been limited. An average selling price of white book paper, conversion coated, for example, will be about K1,400 per ton f.o.b. mill. On this basis the gross profit per ton will be K1,157 or K1,15,70,000 annually. This "profit" is not a true representation, as 93% of over-all plant depreciation has been charged to basic, wet and dry pulp departments. Production costs shown in paragraph (g) were computed for average general use printing and writing papers.

The over-all annual gross profit on the estimated K5·92 crore investments:

Gross Profit—Pulp Sales	K24,40,000
Gross Profit—Paper Sales	K55,70,000
	K80,10,000

This represents a 13·5% return on the investment.

Cost of management is deductible from the gross return which appears adequate to provide for management fees and a reasonable net profit.

(i) Recommendations. Pulp and paper have a more assured market than many other industrial products. It is estimated that "normal" consumption in Burma is between 4,000 and 7,000 tons per year, exclusive of newsprint. Consumption probably would be higher were it not for high import prices. It is practically certain that demand will increase considerably. In order to implement the project, the following construction and expenditure schedules are recommended:

Construction

(*1*) Dry season, September 1954, through May 1955.
  - (*a*) Dock with necessary dredging.
  - (*b*) Clearing and grading site for principal buildings.
  - (*c*) Godowns to be used for storage of incoming materials.
  - (*d*) Excavations and foundations for bamboo preparation and digester house.
  - (*e*) Clear reservoir area.
  - (*f*) Begin construction of reservoir dams.

(*2*) Wet season, May 1955, through August 1955.
  - (*a*) No outside construction.
  - (*b*) Receipt of building materials and equipment for open storage.
  - (*c*) Receipt of materials and equipment for indoor storage up to capacity of roofed godowns.

(*3*) Dry season, September 1955, through May 1956.
  - (*a*) Erection of bamboo preparation and digester house.
  - (*b*) Foundations for pulp preparation, drying and baling building.
  - (*c*) Foundations and erection of boiler power house and chemical recovery system.
  - (*d*) Complete reservoir and water supply including treatment plant.
  - (*e*) Construction of bamboo storage facilities.

(4) Wet season, May 1956, through August 1957.

- (a) Erection of machinery, piping and wiring.
- (b) Erection of paper making machinery and finishing.
- (c) Complete inside construction throughout.
- (d) Prepare mill for first operation.

Expenditures

(1) Fiscal Year 1953–54. Designing engineer's costs:		
(a) Preliminary survey, travel and living expenses in Burma.		
(b) Engineers' and draftsmen's time plus office overhead and monthly *pro rata* fixed fee and final design and purchasing.		
(c) Engineers' out-of-pocket expenses. Engineers' average monthly bills for above equivalent of US $45,000, or K213,000 per month for 12 months.	K25,56,000	
Payments on equipment and material purchases:		
(a) Paper machine: letter of credit for 50% of estimated $600,000 = $300,000, or	K14,30,000	
(b) Chip preparation, digestion and pulp washing: 25% of $200,000 = $50,000, or	K2,38,000	
(c) Bleaching, presser, driers, cutters layboys and presser for pulp: 25% of $500,000 = $125,000, or	K5,95,000	
(d) Chemical recovery system: 25% of $200,000 = $50,000, or	K2,36,000	
(e) Power and steam generating equipment: 25% of $900,000 = $225,000, or	K10,70,000	
(f) Caustic and chlorine plant: 25% of $150,000 = $37,000, or	K1,78,000	
Material and initial construction.		
(a) Building material for godowns and buildings to be used as storage facilities during construction $50,000, or	K2,38,000	
(b) Dock construction material $20,000, or	K1,00,000	
Dock construction $20,000	K1,00,000	
(c) Initial site preparation $20,000, or	K1,00,000	K68,41,000
(2) Fiscal Year 1954–55:		
(a) Balance of payments to engineers	K10,00,000	
(b) Payments with order on equipment not previously ordered	K1,50,00,000	
(c) Balance of payments on material and machinery commitments	K2,00,00,000	
(d) Progress payments on construction contract	K20,00,000	K3,80,00,000
(3) Fiscal Year 1955–56:		
(a) Balance of payments on equipment and material commitments	K20,00,000	
(b) Balance of payments on construction contract	K1,13,59,000	K1,33,59,000
TOTAL		K5,82,00,000

(6) Calcium Carbide

(a) Introductory. One of the manufactured products used in every nation is calcium carbide, the source of acetylene gas. Acetylene gas is required in every garage, every shop, and in every factory for heating and cutting metals. It is used for illumination and for house heating and in laboratories when other gas is not available. The acetylene gas is generally shipped from the gas generating plant in steel cylinders, which being portable, may be used anywhere. Large users often generate their own acetylene gas and pipe it to points of use in their plants.

As no calcium carbide is manufactured in Burma, it must be imported. Yet it is easily manufactured from raw materials that are found in abundance in Burma. These are limestone, charcoal, (or coke) and electric power.

(b) The market. The past and current use of calcium carbide is shown in the accompanying table of imports:

IMPORTS OF CALCIUM CARBIDE

Fiscal Year	*Quantity*		*Value*	
	Cwt.	*Tons*	*Total Ks*	*K per Ton*
1936–37	11,225	561	1,52,752	272.28
1937–38	12,965	648	1,63,830	252.82
1938–39	7,937	397	97,737	246.18
1939–40	11,579	579	1,71,362	295.96
1940–41	12,933	647	2,04,541	316.18
1945–46	58	3	3,933	1,311.00
1946–47	363	18	9,917	550.94
1947–48	9,386	469	2,44,560	521.02
1948–49	2,159	108	57,567	533.02
1949–50	N.A.	N.A.	N.A.	N.A.
1950–51	2,698	135	56,328	417.24
1951–52	2,805	140	96,733	690.95

The prewar use averaged about 600 long tons per year. The future use will increase rapidly as more industrial plants are built. The new steel products plant will require a large quantity for cutting up steel scrap. The estimated future demand should easily reach 3,000 to 5,000 long tons per year.

While the amount of calcium carbide imported into Burma does not require the expenditure of much foreign exchange it is an essential industrial material that should be produced nationally. It is therefore proposed to establish in Burma a calcium carbide plant having a capacity of 10 long tons per day, or 3,000 long tons per year.

(c) Plant location. The plant can be located anywhere that the raw materials and power are available. The Akyab area has been selected as the best location for the plant not only because the raw materials and power are available, but because a large portion of the product will be used for the manufacture of vinyl plastics. The hydrochloric acid required for this process will come from the caustic and chlorine chemical plant to be operated in connection with the pulp and paper factory.

(d) Raw materials. The 10-ton-per-day calcium carbide plant will require the following materials:

9·50 long tons of quicklime per day
6·50 long tons of coke or charcoal per day
60·00 long tons of water for cooling
38,000 kWh of electric current for the 1,800 kW furnace.

The quicklime will be furnished from the same source that will supply the pulp and paper factory. The charcoal will be produced locally. Power will be supplied from the Saingdin Falls hydroelectric project.

(e) The process. Quicklime and charcoal (or coke) are crushed separately to a minus one inch size and stored in separate bins. As required, the two materials are withdrawn from the storage bins, weighed separately, mixed thoroughly, and placed in the furnace charging bins. The furnace is of the electric arc type, operating continuously.

The heat causes the mixture to melt and the calcium carbide is formed. The molten product is tapped from the furnace at intervals. Special chill cars receive the molten material. After solidifying in the cars the solid carbide is dropped into a breaker pit to be broken into chunks. Crushers reduce the chunks into desired final sizes. The finished carbide is then packed in air- and water-tight containers.

(f) Cost of plant. A plant to produce 10 long tons per day of calcium carbide is estimated to cost as follows:

Item	*Installed Cost* K
Coke and Lime Storage and Crushing Equipment	1,04,784
Weighing and Charging Bins and Equipment	1,57,176
Furnace and Equipment	2,78,480
Chilling, Breaking and Drum Loading	2,10,512
Buildings	5,47,520
Ocean Freight and Insurance	1,00,000
Misc. Construction and Engr.	4,72,000
Construction Overhead	1,00,000
Total less Real Estate	19,70,472
Real Estate	50,000
Total Plant Cost	20,20,472
Working Capital	4,72,000
Total Capital Required	24,92,472

Approximately K17,44,730 will be foreign exchange and K7,47,742 local currency. It will require about 18 months to complete the plant after engineering services have been retained.

(g) Financing. The proposed plant may be either a wholly owned GUB corporation, or be owned jointly by the GUB and private interests. If a wholly owned GUB corporation, the entire capital requirement will be furnished by the GUB to the carbide manufacturing corporation formed for this purpose. This loan will bear interest at the rates of 4% and 5% for the local and foreign currency advanced, respectively. The loan, with compound interest, will be repaid in equal annual payments whose number will coincide with the estimated useful life of the equipment, which has been placed at 25 years.

The annual cost of carrying the capital loan is calculated as follows:

	Factor	*Annual Cost (K)*
Local Currency	K7,47,742 × ·06401	47,865
Foreign Currency	K17,44,730 × ·07095	1,23,790
Total Annual Cost		1,71,655

This cost will be prorated into the unit cost of production. No depreciation, as such, will be assessed against costs as no capital reserve will be accumulated. Any additional capital will therefore be obtained and repaid in the same manner as the original loan. Such wholly owned GUB corporations would operate as tax free, non-profit units, and would be exempt from import duties.

(h) Manufacturing cost. The manufacturing cost has been estimated as follows:

	Annual Total Cost K	*Cost per Long Ton K*
Operating and Repair Labor	1,50,000	
Operating and Repair Supplies	80,000	
Lime	4,27,500	
Charcoal	75,000	
Power	5,38,080	
Electrodes	60,000	
General Works Expense	2,36,000	
Containers	1,00,000	
Administration and Sales Expense	2,36,000	
Amortization of Loan	1,71,655	
Insurance	1,00,000	
Cost of Sales	21,74,235	
Divisor (3,000 L.T.Year)		724.74

Power must be furnished at K0·0472 per kWh to make this project feasible.

	K	K/L.T.
Ex-Warehouse Cost Rangoon of Imported Product	22,38,690	746.23
Cost of Sales	21,74,235	724.74
Gross Profit	64,455	21.49

The above ex-warehouse value in Rangoon is the declared c.i.f. import value of calcium carbide plus port charges, stevedoring and warehousing costs. No duty or dealer's markup and profit is included.

The duty and dealer's markup and profit on the imported carbide are believed to be sufficient to offset the freight charges from Akyab to Rangoon, which should not exceed K50 per long ton. The current selling price per long ton of carbide ex dealer's warehouse in Rangoon is K913. It is thus believed that carbide manufactured near Akyab can be sold at a fair profit at the present Rangoon prices for imported carbide. The project is thus justified from an economic standpoint as well as from the viewpoint of national interest. It should be implemented in the intermediate plant.

(i) **Acetylene.** The ultimate use of calcium carbide is to produce acetylene gas, which is obtained in a generator when water is added. Eventually acetylene gas will be distributed in tanks as is done in every industrial country. The cost of such acetylene generating plants varies with the size. Commercial plants are rated in accordance with the weight of calcium carbide charged into the unit. A one-ton plant complete will cost about K1,13,280, and a three-ton plant will cost about K1,69,920.

A production of 4·5 cu. ft. of acetylene gas may be generated from one pound of calcium carbide at 60° F., and 30 in Hg pressure. Thus a one-ton generator will yield 9,000 cu. ft. or 620 pounds of gas, and a three-ton unit will produce 27,000 cu. ft. or 1,860 pounds.

(6a) Vinyl Compounds

An important series of industrial chemical products can be manufactured from calcium carbide as a base raw material. Two of these are vinyl acetate and vinyl chloride. These vinyl compounds would be particularly useful in Burma as a substitute or replacement for leather because of the particular advantage of vinyl over leather in a tropical climate where leather deteriorates rapidly due to mold.

Much imported vinyl is presently used in Burma, although the quantity is concealed in the import statistics under other classifications. It is seen in many consumer goods. Much enters the country in the form of ladies' hand bags, belts or suspenders, all of which could be made in Burma. The process is simple and should be profitable. It might be desirable to sell the material in either sheet, molding powder, or other forms, to other industries which would manufacture the consumer goods.

Because the calcium carbide would be made at the chemical industry center near Akyab, and because pure hydrochloric acid would be produced as a by-product in the same group of plants, the vinyl plants should be located on the same site.

The proposed plant would use five tons per day of calcium carbide (50% of the plant output), plus additional in the form of acetylene. The vinyl plant proposed would produce the following products:

	L.T./Day
Vinyl Chloride Monomer	3·0
Vinyl Acetate Monomer	1·0
Vinyl Chloride-Acetate Polymers	4·0

	K
The Vinyl Chloride Plant and equipment, erected, is estimated to cost	6,51,360
Buildings and Utilities	4,29,520
Engineering, Construction and Start-up	2,16,176
Contingencies	1,29,704
Ocean Freight and Insurance	95,110
	15,21,870
Real Estate	50,000
Total Plant Cost	15,71,870
Working Capital	2,26,560
Total Capital Required	17,98,430
The Vinyl Acetate Monomer Plant	
Total Capital	10,70,685
The Vinyl Chloride-Acetate Copolymer Plant	
Total Capital	42,60,085

It is estimated that the vinyl chloride monomer can be produced for about K0.54 per pound, or K1,219.60 per long ton. The production cost of the vinyl acetate monomer is estimated to be K0·944 per pound, or K2,114.56 per long ton. The production cost of the vinyl chloride acetate copolymer is estimated to be K1·541 per pound, or K3,451.84 per long ton.

It is believed that at such prices the plants could produce these materials and sell them profitably in Burma below the prices of imported products of the same grade and type. A complete project should be developed covering these plants. If this reveals them to be economically feasible they should be placed in the intermediate plan for implementation.

(7) Caustic Soda and Chlorine

(a) The market. This production facility is intended to operate in conjunction with the projected pulp and paper mill whose annual demand for caustic soda is 640 short tons and for chlorine, 3,360 tons. Location of the plant adjacent to the paper mill will result in lower production costs since management of the two operations will be combined into one. Furthermore, it will not be necessary to prepare the chemicals for shipment as they may be piped directly to the paper mill in gaseous and liquid form.

The proposed capacity of the plant is 25 tons of chlorine and 28 tons of caustic soda per day. On the basis of 300-day-per-year operation, about 3,800 tons of chlorine in excess of paper mill consumption will be available for use in the proposed chlorine-base chemical industries, and about 7,500 tons of caustic soda will be available for sale in domestic and export markets.

Soap production in the country is increasing to the extent that about 3,000 tons of caustic soda will be used for this purpose alone. There will remain about 4,500 tons for other general industrial uses.

The existing market for chlorine in the country has been negligible due to the high cost of importation. Imports have averaged only about 300 cwt. annually. Besides an expected greater general use for water purification, the introduction of domestically produced chlorine, will permit the manufacture of chlorine-based chemicals such as DDT, hypochlorides and disinfectants, a project which, as an aid to the public health program, should receive priority. A DDT plant of optimum size for Burma, would produce about five tons of the insecticide per day requiring 6·2 short tons of chlorine. Paradichlorobenzene and other chlorine derivatives recommended for future production require chlorine as a basic raw material.

(b) Possibility of domestic production. (1) The process is essentially the electrolytic decomposition of common salt when dissolved in water into its component sodium and chlorine, the former recombining with water to form caustic soda. Besides salt, the other basic requisite is electric power. Salt is available, and, with modifications to existing salt farms, could be produced in sufficient quantity to fulfill anticipated future needs.

Location of the plant adjacent to the paper mill will permit using the latter's electricity supply whether from Saingdin Falls hydro development or from its own generating power plant. About 4,000 kVA will be required for full operation.

(2) Chlorine can be produced for about K216 per short ton and caustic soda for about K197 per short ton. Production costs are detailed in the project report.

Caustic soda in excess of that required for the paper mill will be available. While caustic soda (lye) is a basic chemical and used to a greater or less degree in almost every country in the world, export possibilities in competition with the large chemical companies in both the east and the west are rather uncertain.

(3) Like most chemical manufacturing processes, a relatively small labor force is required although it must be drawn from the ranks of skilled labor or those amenable to training for skilled jobs. Since the labor force will be small, about 11, the employment opportunities will not be a major contribution to the general welfare. Operation will, however, present opportunities to chemical graduates of local schools and university for practical manufacturing training and employment.

(c) Recommendations. The subject plant is a necessary adjunct to the paper mill, a project that has a high priority in the industrial development scheme. Schedules for expenditure and construction should coincide with those for the paper mills.

It is possible and probably desirable to correlate capacity of the plant with demand. It may not be advisable to construct the plant initially for a capacity in excess of paper mill demand until such times as the chlorine based chemical plants are finalized. Such procedure is technically possible and costs of additions would not exceed losses and idle equipment if full production capacity were prematurely installed.

(d) Economic feasibility. The proposed plant will be of conventional design using 76 Hooker S type (diaphram) cells. Auxiliary equipment description and process details are contained in the project report. The total capital cost is estimated at K1·07 crores of which 70% or K74 lakhs will be required in foreign exchange.

The raw materials, which will be available in the country, are salt, sulphuric and hydrochloric acid, and electricity.

Annual raw material requirements are:

Salt	15,800 tons
Sodium Carbonate	200 tons
Sulphuric Acid	890 tons
Graphite (anodes)	12 tons
Hydrochloric Acid	14 tons

Graphite in the form of anodes and sodium carbonate will be imported. Chemicals that must be imported are available in India and Japan as well as in Europe and the UK.

(e) **Production costs.** Total mill cost for both products averages K408 per ton. Since both products are produced coincidentally mill costs are divided as follows: chlorine K216, and caustic soda K192 per ton. Selling prices based on these mill costs should compare favorably with imported costs for general market consumption and will be under imported costs for direct use in the paper mill.

(8) Jute Bag and Twine Mill

(a) **The market.** Burma's average annual postwar importation of jute rice bags is about 24 million requiring an average annual foreign exchange outlay of about K3,00,00,000. The demand for bags and the outlay of money required to purchase them warranted consideration of ways and means of lowering costs by developing domestic sources of supply and processing plants. Prior to the war, consumption of jute bags of all types averaged 52 million.

A project report on the economic feasibility of producing rice bags and twine from imported raw fiber until such time as domestic jute harvests can supply the demand, has been completed, and submitted to Government. This project study indicates the feasibility of establishing a bag and twine mill having an annual two-shift capacity of 6,000,000 bags and 281,000 lbs. of seam and mouth sewing twine as an initial unit in an industry that will eventually supply the total domestic demand.

In the interest of low-cost production, the State Agricultural Marketing Board was consulted regarding standardization of export rice bags. A preference based on experience in their use was expressed for the type of bag known in the trade as Heavy "C," having the following specifications.

Size	*Bag Weight*	*Rice Capacity*
40 in. × 28 in.	2·25 lb.	210 lb.
36 in. × 26½ in.	2·00 lb.	160 lb.

The present annual demand for bags of the above sizes is approximately 19,000,000. Since the proposed mill's capacity is about one third of the demand, a steady market for entire output is assured.

(b) Possibility of domestic production. (1) The proposed mill will use imported raw jute from Pakistan until such time as domestic harvests satisfy the demand. The mill will provide a stimulus to local jute growing, since harvests can be processed at a profit rather than being supported by subsidy and stored for an uncertain length of time and for an uncertain end use as would be the case if Government continued to support the growing program without having any immediate use for the raw fiber.

The prime criterion of the project is economy. For the proposed mill's principal product, the current costs are:

Imported Heavy "C" selling price in Rangoon	K1,240.00/ton
Domestic Heavy "C" selling price in Rangoon	1,173.00/ton
Difference	67.00/ton

The imported bag price above is exclusive of the current Indian export duty of K174 per ton. Over the past four years, this duty has varied widely. Under pressure from trade groups, the Indian Government is considering abolition of export tax on bags, hence no consideration was given to savings from that source.

The K67 per ton saving amounts to an annual total of K40,20,000 or a return of 5·4% on the capital investment. Reduction in foreign exchange expenditures for the first years of the operation is not important since raw material purchases will be made in sterling. Financial circles anticipate devaluation of 40% in Pakistani currency in 12 to 18 months. Jute circles expect a reduction of 15% in raw fiber as a result. This currency value adjustment is speculative as far as the subject mill is concerned, but is mentioned as a probable aid in the first few years of operation.

(2) Although a commodity of prime importance in the economy, jute has not been grown on a commercial scale. Bengal fields kept pace with world demand making cultivation in other countries unnecessary. However, people in the Indian jute trade have stated that there is no reason why it should not grow in commercial quantities in Burma. Experimental plantings have indicated that the plant will grow in the country. However, plantings have not been sufficiently diversified to disclose the best growing areas. The proposed mill will consume the harvest from about 12,000 acres. It should not be difficult to bring that acreage under production in four years.

(3) The project will provide much-needed employment opportunities in a town (Akyab) where they would be particularly welcomed. Besides the direct employment of over 600 persons in the mill, indirect employment of twice that number including cultivators is estimated. The mill payroll will undoubtedly contribute to the general economic welfare of the Akyab area and stimulate its growth.*

(4) Experience in the cotton spinning and weaving factory has demonstrated that machine operators can be readily trained for the relatively simple tasks of textile machine tending. The manual dexterity of Burmese workers is as good as that of their counterparts in other countries. The same experience, however, has revealed an absence of discipline and responsibility on the part of the labor force. The jute mill's products will be competitive with imports; its labor must be as efficient and productive as that of its competitors, else it has little chance of success.

It is suggested that the manager, mechanical and production overseer, and office master and accountant be recruited from the jute mill center along the banks of the Hooghly River in India. There are qualified persons there with years of experience in all phases of the jute business who are available and who would respond to attractive offers. Given proper authority, the suggested three-man team could handle the mill. The operation is not believed to be large enough to warrant a management contract.

(c) Economic feasibility. (1) A 140-loom mill using the latest type high production and labor saving equipment to the extent justified by relative equipment and labor costs, commensurate with the type of material produced, and capable of using as low cost fiber as possible, is proposed for production of the bags specified above. The proposed capacity is based on a 70% loom efficiency. The capital cost of the plant installed and ready to operate is estimated as:

Machinery and equipment	K49,59,000
Buildings	K25,07,000
	K74,66,000

The estimated foreign exchange expenditure is £436,000 and local currency expenditure K16,68,000.

(2) Production costs on a per ton of raw jute basis are summarized below (see project report for details):

	K
Jute	638.40
Other Materials	28.10
Labor	165.20
Power	104.60
Maintenance and Repairs	9.83
Management and Office Overhead	10.65
Fixed Charges	141.11
Mill cost per ton	1,097.89

Total Landed Cost Per Ton:

Mill Cost	1,097.89
Loading at Akyab and unloading at Rangoon per ton	5.00
Freight Akyab to Rangoon	70.00
Total cost at Rangoon	1,172.89

Say K1,173 per ton.

(3) The project's contribution to the national welfare will depend primarily upon the income the cultivator will receive. Jute will be competitive with rice from the cultivator's point of view. The paddy cultivator's average gross revenue is K85 per acre; net revenue varies so widely that an average is difficult to establish.

(4) As stated, average mill cost of imported fiber is K640 per ton. Assuming a crop yield of one half ton per acre of average grade, which is a reasonable expectation, and similar prices for domestic and imported fiber, the cultivator could receive about K300 per acre less charges of brokers and middle men. Net revenue to the cultivator for jute fiber may not exceed that for paddy since the man-hours of labor required per acre are at least twice that for paddy production.

(5) It would be speculative to predict long range over-all benefits to cultivators for a new commodity. Jute growing has afforded a living to thousands in India and Pakistan, and once established in Burma there is no apparent reason why it should not become a profitable cash crop in those areas where it will grow best.

(6) It is not necessary that all fiber grown be high grade. On the contrary, the use of an undue proportion of high grade fiber in bags would be wasteful since they have been traditionally and satisfactorily woven from the lower grades. High grade jute goes into hessian (burlap) a product for which there is little use at present in Burma.

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* It is now proposed to construct the initial plant at Rangoon.

(d) Recommendations. It is recommended that the mill project be initiated. Expenditure and construction schedules are suggested below:

(1) *Expenditure Schedule*

Fiscal year 1953–54:	*K*	£
Payment on order for machinery ⅓ of £372,320	—	124,107
Payment on order for structural steel ½ of £22,500	—	11,250
Site preparation and preliminary construction foundations, etc.	3,00,000	—
Fiscal year 1954–55:		
Final payments on machinery ⅔ of £372,320	—	248,214
Final payment on structural steel ½ of £22,500	—	11,250
Progress payments on building construction and machinery erection	10,00,000	33,060
Fiscal year 1955–56:		
Final payments on construction and machinery erection	3,68,000	8,334
Total	16,68,000	436,215

(2) *Construction Schedule*

Jute machinery manufacturers promise 18 month initial equipment delivery with final deliveries within 28 months of order placement which permits early plant completion. In general, construction will parallel the expenditure schedule. The following schedule is proposed to provide for completion of the mill within a three-year period after placement of principal equipment and material order:

Fiscal year 1953–54

- (*a*) Complete design of building in accordance with machinery manufacturer's layout.
- (*b*) Grade site.
- (*c*) Preliminary construction work on dock or improve existing one. Type of dock, if any is required, depends upon final site selected.
- (*d*) Prepare building and machinery foundations.

Fiscal year 1954–55

- (*a*) Estimated delivery of structural steel six months from order placement. Erection of structural steel framing, building walls and roof of mill building.
- (*b*) Begin wiring and piping.
- (*c*) Begin machinery erection.

Fiscal year 1955–56

- (*a*) Complete machinery erection.
- (*b*) Installation of all piping and sprinkler system.
- (*c*) Construction of godowns and auxiliary buildings.
- (*d*) Initial start of production under supervision of manufacturer's engineers.

b. The Greater Rangoon Industrial Group*

Rangoon has become the chief industrial center of the Union of Burma. It is the terminal of ocean vessel routes, of river transport routes, of the railway system, of the highway system, and of the air transport system of Burma. It is, therefore, the banking, commercial, importing and exporting, manufacturing and distributing center of the nation, in addition to being the seat of the Government.

Agricultural and other products move to market through Rangoon. Some are processed in Rangoon and are exported. Others are processed for both the export and domestic markets. The proposed industrial products derived from materials now moving into Rangoon should therefore be manufactured in Rangoon.

In addition, products manufactured in or imported through Rangoon can be distributed throughout the nation more readily from Rangoon than from any other point. As many of the products to be manufactured in the proposed new industrial plants are for domestic use only, the availability of these multiple transportation systems dictates the selection of Rangoon as their best location.

(9) Cotton and Cotton Textile Products

(a) The market. The value of cotton textiles annually imported into Burma is greater than the value of any other commodity. Cotton represents a basic need in the living conditions of this country where over 75% is used for clothing and the remainder for necessary household and industrial items. For the year of 1951–52, Burma imported over K20 crores of cotton goods from foreign countries, and for the preceding year of 1950–51, cotton imports into Burma totaled almost K25 crores. The greater part of these imports were composed of cotton piecegoods; cotton twist and yarn being next in value. The following table shows the interrelation between the main classes of textile imports in regard to both value and quantity.

COTTON IMPORT SUMMARY

Year 1950–51

Type of Import	*Quantity*	*Value*
Cotton Piecegoods (undyed)	70,785,273 yds.	9,31,30,410
Cotton Piecegoods (colored, printed, dyed)	51,522,407 yds.	11,03,76,498
Cotton Twist and Yarns	8,739,197 lbs.	4,26,02,023
Raw Cotton	1,162,560 lbs.	22,72,042
Total		K24,83,80,973

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* The Rangoon District has been named "greater" so as to include Moulmein and some other points.

Year 1951–52

Type of Import	*Quantity*	*Value*
Cotton Piecegoods (undyed)	41,022,057 yds.	4,11,78,556
Cotton Piecegoods (colored printed, dyed)	27,899,655 yds.	4,49,28,384
Cotton Twist Yarns	13,698,666 lbs.	10,89,20,982
Raw Cotton	4,118,016 lbs.	81,36,471
Total		K20,31,64,393

From this picture, it can be seen that there is a substantial weavers' market for imported cotton twist and yarn as well as a consumers' market for cotton piecegoods. Also, there is a preference for colored, printed or dyed cotton piecegoods as compared to undyed piecegoods.

The bulk of cotton yarn used in Burma lies between Nos. 11 to 20 count* as indicated by the following cotton yarn import table. For the year of 1951 the percentage of Nos. 11 to 20 count of imported yarn is shown as approximately 75% by weight. For counts of No. 21 and over, the proportion consumed is approximately 24%, and for counts No. 10 and under the remainder is slightly less than 1% of total imported counts.

GREY (UNBLEACHED) COTTON YARN IMPORT CLASSIFIED BY COUNT

Count of Weaving Yarn	*1950–51*		*1951–52*	
	Pounds Weight	%	*Pounds Weight*	%
Nos. 1–10	64,412	0·9	752,001	6·3
Nos. 11–20	5,575,292	75·4	10,345,087	85·9
Nos. 21–30	235,527	3·2	95,206	0·8
Nos. 31–40	1,079,300	14·7	845,782	7·0
Nos. 41 and over	430,150	5·8		
Totals	7,384,681	100	12,038,076	100

Cotton cloths woven from No. 20 count yarn and less are used mostly by the rural population in longyis and in long cloth for shirting. Heavier counts of No. 10 yarn are made into blankets and fishing twine. The No. 5 yarn is utilized for candlewicks, fishing twine and canvas. Inasmuch as approximately 80% of Burma's population is rural, a proportionately large amount of No. 20 count yarn is utilized in longyis and wearing apparel.

The lighter weights of cotton cloth woven from No. 21 to No. 80 count yarn are used in longyis principally by the urban population of Burma which consists of about 20% of the total populace. The higher counts of No. 80 to No. 100 are used in en-gees and shirting, also by the urban people.

The weaving of the various count yarns into cloth varies on much the same ratio. Of the 250,000 hand looms in Burma, most are located in the rural districts. The output of the greater number of hand looms goes directly to serving the needs of the rural people for cloth made from No. 20 count yard and similar grade. The power looms, on the other hand, have a tendency to weave the finer grades of material such as are used by the urban people. The number of power looms is extremely limited. Private industry may be credited with possibly 200 power looms. Another 200 power looms are operated at Thamaing by the Government cotton spinning and weaving factory. The Government mill does not weave cloth from the higher counts of imported yarn, but utilizes its own production of yarn which is composed of No. 10 to No. 20 count for the greater part. The 200 power looms operated by private industry rarely use any yarn heavier than single No. 30 and often utilize double No. 80, sometimes going to double No. 120 when permit for import is available, which is seldom.

The over-all market potential of Burma and current consumption of cotton goods can most effectively be determined by calculating the total amount of cotton cloth annually produced in Burma from the amount of cotton yarn consumed, and adding all cloth imports to this figure. This annual yardage divided by the population will render an accurate picture of the consumption of cloth and wearing apparel per person per year. By comparing this figure to similar rates of other countries, a close estimate of Burma's market potential can be obtained.

The total amount of cotton cloth produced in Burma by hand looms and machine looms alike can be determined directly by the amount of cotton yarn consumed. The availability of cotton yarn is from two sources only: the cotton yarn imported and the cotton yarn spun from cotton by the Government spinning factory. At the present time, there are no other spinning mills in operation other than the Government factory*; and the amount spun by hand is small and carries no commercial significance.

For the year of 1951–52, the total amount of cotton cloth yardage available through import and indigenous production is estimated as follows:

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* All "counts" refer to weaving counts unless otherwise specified.

* Capacity rated at 4,675,000 lbs./yr. (90,000 lbs./wk.), or 92% of absolute efficiency.

TOTAL ANNUAL CONSUMPTION OF BURMA COTTON CLOTH YARDAGE 1951–52

Cotton yarn imported	13,698,666 lbs.
Cotton yarn spun by Government mill, 1951 at 55·5% capacity*	2,600,000 lbs.
Total cotton yarn available at 5 yds. cloth to 1 lb. cotton yarn (average)	16,298,666 lbs.
Cotton cloth produced in Burma	81,493,330 yds.
Imported cotton piecegoods (undyed)	41,022,057 yds.
Imported cotton piecegoods (colored, dyed, printed)	27,899,655 yds.
Cotton cloth total for year 1951–52†	150,415,042 yds.

If the total amount of this cloth is divided by 18,500,000 people (estimated 1951–52 Burma population), the quotient of 8·1 yds. is the amount of cotton cloth used per person per year of 1951–52 in Burma. If this amount were further increased to 10 yds. per person per year, this would be sufficient for:

5 yds.	2 longyis/year
5 yds.	2 shirts/year

10 yds/person/year ∴ cotton cloth

In comparison to other countries, Burma should set an objective of approximately 30 yds. per person per year where 75% would be utilized for clothing and the remainder for household (curtains, blankets) and industrial (canvas, tire fabric, shoes, power transmission, conveyor belts) requirements. A table of cotton cloth consumption averages of other countries is as follows:

CONSUMPTION BY COUNTRY OF COTTON PIECEGOODS PER PERSON PER YEAR

USA	60	yds/person/year	
Europe	54	,, ,, ,,	
Japan	35	,, ,, ,,	
Burma Objective	30	,, ,, ,,	555,000,000 yds/year
India	28	,, ,, ,,	
China	20	,, ,, ,,	
Burma (1951)	8	,, ,, ,,	150,415,042 yds/year

These figures demonstrate the current textile market in Burma and also the possible future indigenous textile market.

The operation of spinning and weaving of cotton is of basic and over-all importance in the textile field. The end operation of bleaching, finishing, dyeing and printing is a comparatively light and inexpensive phase of textile treatment, but the return investment is considerably greater. Finished cloth will bring an approximately 50% greater price than unfinished cloth of the same quality. Due to the lack of finishing service, almost all handloom products remain unfinished and are consequently sold at a much lower price than similar imported cloth that has been finished at little additional expense. A partial view of market requirement is the imported total of colored, dyed and printed cotton piecegoods into Burma which is considerable and is reflected in the following:

BURMA IMPORT OF COLORED, DYED AND PRINTED COTTON PIECEGOODS

Year	*Quantity*	*Value*
1949–50	54,363,849 yds.	K6,60,04,793
1950–51	51,522,407 yds.	K11,03,76,498
1951–52	27,899,655 yds.	K4,49,28,384

The variety and types of cotton textiles are considerable. Many of the imported lists alone show a classification of as many as 120 different cloth and yarn types. The following list is for the year 1950–51 and gives a tabulated return for 71 different textile items. Each item represents a potential market to be replaced by indigenous production. Many of the higher counts of yarn cannot be spun from indigenous Burma cotton due to the short length of its fiber. But the greater part of all cotton imported into Burma is between the counts of No. 1 and No. 20 and represents about 80% of all textiles consumed. The table opposite gives the total quantity, value, and average unit cost of textile imports.

(b) Possibility of domestic production. The basic consideration in regard to cotton spinning and weaving in Burma is the question of producing the yarn and cloth at a cost equal to or lower than the landed imported cost. There is a plurality of factors that presently make the economic production of textiles an undertaking that requires the utmost in expert technical handling and control. Every phase in the development of cotton from the field to its ultimate use as cloth, demands the most judicious and experienced handling. The world competition in textiles is

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* The Violin Hosiery Works at Insein has 5,000 spindles used mostly for producing "knitting" yarns which are different from "weaving" yarns spun by the Government factory. These spindles are not now being used at the Violin Hosiery Works.

† No exports of cotton piecegoods or yarn are listed for this year.

CLASSIFIED COTTON TEXTILE IMPORTS, 1950–51

	Product	*Quantity (Pounds)*	*Value (Kyats)*	*Unit Cost per lb. or per yard (Kyats)*
1.	Cotton Raw	1,160,000 lbs.	22,72,042	1.95 lb.
2.	Cotton Waste	6,720 lbs.	3,147	0.47 lb.
	Total	1,166,720 lbs.	22,75,189	1.94 lb.
	Cotton twist and yarn			
3.	Grey (unbleached) Nos. 1–10	64,412	1,71,569	2.66 yd.
4.	,, ,, Nos. 11–20	5,575,292	2,51,95,400	4.51
5.	,, ,, Nos. 21–30	235,527	12,00,970	5.09
6.	,, ,, Nos. 31–40	1,079,300	43,74,135	4.05
7.	,, ,, Nos. 41 and over	430,150	25,91,774	6.02
8.	Grey twofolds (doubles) Nos. 1–50	48,000	1,56,689	3.26
9.	,, ,, ,, Nos. 51 and over	154,400	11,66,798	7.55
10.	White (bleached) Nos. 1–40	451,862	25,37,877	5.61
11.	,, ,, Nos. 41 and over	112,239	8,44,725	7.52
12.	,, twofolds (doubles) Nos. 1–50	12,800	1,07,652	8.41
13.	,, ,, ,, Nos. 51 and over	43,380	3,67,502	8.47
14.	Colored cotton yarn Nos. 1–20	nil	nil	
15.	,, ,, ,, Nos. 21–40	716	9,527	13.30
16.	,, ,, ,, Nos. 41 and over	6	8	1.33
17.	,, twofolds (doubles) Nos. 1–50	826	9,399	11.37
18.	,, ,, ,, Nos. 51 and over	nil	nil	
19.	Mercerized cotton yarn Nos. 1–40	12,221	1,31,141	10.73
20.	,, ,, ,, Nos. 41 and over	87,000	8,98,668	10.32
21.	,, ,, ,, twofolds (doubles) Nos. 1–50	nil	nil	
22.	,, ,, ,, ,, ,, Nos. 51 and over	99,013	12,86,208	12.99
23.	Unspecified cotton yarn and twist Nos. 1–50	254,600	8,76,355	3.44
24.	,, ,, ,, ,, ,, Nos. 51 and over	77,453	6,75,626	8.72
25.	Cotton thread for sewing or darning	451,184	63,15,992	13.99
26.	Other sorts of cotton thread	97,288	9,87,744	10.15
27.	Yarn made of staple fiber mixed with other materials	nil	nil	
	Totals	9,287,669	4,99,05,759	5.37 yd.
		Quantity (Yards)	*Value (Kyats)*	*K/yd.*
	Cotton Piecegoods			
28.	Plain grey chadars of cotton	10	80	8.00
29.	,, ,, dhotis, saries and scarves of cotton	12,324	10,399	0.84
30.	,, ,, drill and jeans of cotton	889,559	16,79,708	1.88
31.	,, ,, jaconets including madapollams, mulls and cambrics of cotton	9,970	8,568	0.85
32.	Plain and grey longcloth and shirting of cotton	8,763,123	2,33,80,658	2.66
33.	Plain grey shirtings of cotton	71,805	1,10,464	1.53
34.	,, ,, cloth of unspecified descriptions of cotton	130,058	1,15,132	0.88
35.	Checks, spots and stripes in white of cotton	246,068	3,59,385	1.46
36.	White dhotis, saries and scarves of cotton	174,567	2,49,637	1.43
37.	White drills and jeans of cotton	197,329	3,54,164	1.79
38.	White cotton flannels and flannelettes of cotton	36,630	40,590	1.10
39.	White jaconets, madapollams, cambric and muslins of cotton	3,110,699	56,98,826	1.83
40.	White lawns of cotton	4,766,269	73,72,188	1.54
41.	White longcloth and shirtings of cotton	10,886,628	5,19,71,173	4.77

Cotton Piecegoods (contd.)	*Quantity (Yards)*	*Value (Kyats)*	*K/yd.*
42. White mulls of cotton	761,834	6,70,687	0.88
43. White shirtings of cotton	45,428	73,682	1.62
44. White twills of cotton	75,684	1,68,979	2.23
45. Other cotton piecegoods (white bleached)	607,288	8,66,090	1.42
46. Printed cambrics including madapollams, muslins, mulls, and jaconets of cotton	5,720,691	99,98,686	1.74
47. Printed checks, spots and stripes of cotton	7,000,178	1,19,62,077	1.70
48. Printed dhotis, saries and scarves of cotton	12,314	26,032	2.11
49. Printed drills and jeans of cotton	8,010	9,679	1.20
50. Printed cotton flannel and flannelettes of cotton	nil	nil	
51. Prints and chintz of cotton	504,590	7,60,739	1.50
52. Printed shirtings and twills of cotton	26,243,826	7,07,20,336	2.69
53. Other printed piecegoods of cotton	2,138,680	2,92,63,668	1.38
54. Dyed cambrics including madapollams, muslins, mulls, and jaconets of cotton	1,016,193	12,11,314	1.19
55. Dyed checks, spots and stripes of cotton	175,427	2,73,547	1.55
56. Dyed dhotis and scarves of cotton	nil	nil	
57. Dyed drills and jeans of cotton	621,427	10,35,985	1.66
58. Dyed flannels and flannelettes of cotton	56,987	55,086	0.96
59. Dyed prints and chintz of cotton	24	73	3.04
60. Dyed shirtings and twills of cotton	4,669,315	56,92,122	1.21
61. Dyed cotton material for coats and trousers	246,887	3,65,062	1.47
62. Other dyed cotton piecegoods	1,382,673	27,80,843	2.01
63. Woven colored cambrics including madapollams, muslins, mulls, and jaconets of cotton	2	20	10.00
64. Woven colored checks, spots, and stripes of cotton	74,826	1,16,001	1.55
65. Woven colored cotton materials for coats and trousers including cashmeres, serges and tweeds of cotton	123,714	1,70,826	1.38
66. Woven colored drills and jeans of cotton	—	30	
67. Woven colored flannels and flannelettes of cotton	504	5,525	10.96
68. Woven colored cotton longyis and sarongs	745,185	10,34,533	1.38
69. Woven colored cotton shirtings	233,717	3,25,923	1.39
70. Colored cotton velvet and velveteens	45,497	1,75,057	3.84
71. Other sorts of woven colored cotton piecegoods	501,740	6,93,874	1.38
Total Yards	83,307,680	20,35,07,448	2.44 yd.

Grand Total:

Raw Cotton and Waste	1,166,720 lbs.	K25,56,88,396
Cotton Twist and Yarn	9,287,669 yds.	
Cotton Piecegoods	82,307,680 yds.	

so great and prices are so delicately balanced that there is small margin for error or inefficiency. Agricultural control and guidance for the growth and distribution of cotton and cotton seed receives keen attention from other competing countries, and Burma will fall behind, if it neglects this basic issue.

Cotton ginning, hydraulic packing presses and efficient utilization of valuable cotton seed for its many by-products must be effectively controlled. Market prices for cotton from the field to the gin and through the spinning, weaving and finishing processes to the consumer must be supervised and controlled for the continued welfare of the farmer, manufacturer and merchant. If a section of one phase experiences bankruptcy due to unbalanced market prices, the entire economy of cotton operations can be imperiled.

When indigenous raw cotton is utilized for the manufacture of yarn and cloth, the margin of operations is slightly greater than when imported yarn is used to weave cloth. This does not imply that it is impractical to import yarn and manufacture cloth here in competition with the huge mills of India, Japan and England. The greater number of textile mills presently operating in Burma utilize imported yarn to advantage. Their operations are eclipsed by the tremendous textile industries of other countries, but with their own careful management and with general import control by the Government they are operating soundly. The textile industry must endeavor to operate with minimum import control so as to minimize any added burden of increased living costs. Much encouragement should be given to their operation in order that they may grow in size and that their efficient operation may result in reduced costs and greater comforts for the Burmese people. With continued improvements and increased availability of trained personnel, a future objective will exist in the direction of textile exports. But at the present, attention must first be directed to satisfying indigenous consumption.

Advantages which will assist Burma greatly in meeting the competition of foreign imports are the following:

1. Use of high speed machinery.
2. Working the factory at 3 shifts around the clock 24 hours per day (or even a fourth shift to meet 350 working days per year).
3. Integration of spinning, weaving, finishing and coloring processes.
4. Concentration on continuous production of standard counts of yarn and standard cloth types.
5. Comparative freedom from restrictions by the workers on such things as the number of machines one man is permitted to handle.
6. The best points of English, Japanese, Chinese, Indian and American systems of textile production can advantageously be adapted.

(c) Input materials and utilities. Burma cotton is essentially a short staple cotton and is not adaptable to spinning the higher count yarns. For weaving purposes, it is best adapted for spinning No. 5 to No. 12 counts. A count of No. 16 is possible but No. 12 count is considered the highest count of commercially competitive yarn now practicable from present Burma cotton. The following table is a classified list of the most readily available types of cotton.

For most spinning requirements a percentage of Burma cotton is folded with other long staple cotton and a higher count of yarn is spun from this mixture. Rayon is often used in place of long staple cotton because of its artificial fiber length and its competitive price, and because there is no spinning waste as in cotton.†

GENERAL COTTON TYPES, BURMAN AND OTHER

Cotton Type	*Approx. No. of Acres Grown in Burma*	*Staple Length of Cotton*	*Highest count Weaving Yarn it will produce**
BCF, also known as MRF, Wagale	246,000	$\frac{1}{2}$ in. to $\frac{5}{8}$ in.	No. 5 to No. 10
BCPF, Waggyi	40,000	$\frac{3}{4}$ in.	Up to No. 16
SSS, (Grown in Aungban, north of Shan States)	3,000	$\frac{3}{4}$ in.	,,
Cambodia, (Shan States)	200	$\frac{3}{4}$ in.	,,
M3, (Mahlaing Area)	8,000	$\frac{3}{4}$ in.	,,
M4, (Mahlaing Area)	3,000	$\frac{3}{4}$ in. to $\frac{7}{8}$ in.	,,
M5, (Mahlaing Area)	3,000	$\frac{3}{4}$ in. to $\frac{7}{8}$ in.	,,
M3, Special Experimental (Mahlaing Area)	Experimental	$\frac{23}{32}$ in.	No. 17
Pakistan Cotton	Imported	$\frac{7}{8}$ in.	No. 20
American Cotton	,,	$\frac{7}{8}$ in. to $\frac{15}{16}$ in.	No. 20
M3X, Special Experimental (Burma)	Experimental	$\frac{29}{32}$ in.	No. 26
M4X, Special Experimental (Burma)	,,	1 in.	No. 31
Other General Cotton Types:	Imported	—	
$\frac{15}{16}$ in. to 1 in Fiber	,,	$\frac{15}{16}$ in. to 1 in.	No. 20
1 in. Full	,,	1 in. Full	No. 24
$1\frac{1}{32}$ in.	,,	$1\frac{1}{32}$ in.	No. 30
$1\frac{1}{16}$ in.	,,	$1\frac{1}{16}$ in.	No. 40
$1\frac{1}{8}$ in.	,,	$1\frac{1}{8}$ in.	No. 50
$1\frac{3}{16}$ in. to $1\frac{1}{4}$ in.	,,	$1\frac{3}{16}$ in. to $1\frac{1}{4}$ in.	No. 60
$1\frac{5}{8}$ in.	,,	$1\frac{5}{8}$ in.	No. 150

* These counts are all for weaving yarns; knitting yarns require a longer fiber as they are a soft twist.

TOTAL ANNUAL CONSUMPTION OF BURMA COTTON CLOTH, IN POUNDS WEIGHT 1951-52

Imported cotton piecegoods (undyed)	41,022,057 yds.
Imported cotton piecegoods (colored, dyed, printed)	27,899,655 yds.
Total imported cotton piecegoods at 5 yds. cloth to 1 lb. cotton yarn (average)	68,921,712 yds.
Approx. total weight of imported cotton piecegoods consumed	13,784,342 lbs.
Cotton yarn imported	13,698,666 lbs.
Cotton yarn spun by Government mill	2,600,000 lbs.
Approx. total weight of cotton yarn consumed. (10% allowed for spinning waste)	30,083,008 lbs.
Estimated total cotton lint required to produce annual Burma consumption of cotton goods, 1951	33,400,000 lbs.

As Burma's chief objective is to produce a sufficiency of cotton textiles within her borders so as to reduce imports to a minimum, it is of primary importance to first establish the basic raw materials requirements. An estimate of Burma's total current consumption of all cotton goods will be balanced against the total acreage of cotton necessary to grow the raw product. For the consumption total of cotton goods, the figures on the previous page for the year 1951–52 are indicative of the approximate weight consumed.

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† Spinning waste is 8% with American cotton and about 16% with Burma Wagale.

The total sown acreage of cotton (at an average of 75 pounds cotton lint per acre sown) necessary to produce 33,400,000 lbs. of cotton lint is 445,000 acres. For the year 1952–53 only 294,000 acres of cotton were sown. This amount is only equivalent to 66% of the acreage required to produce the necessary cloth which Burma now consumes. A table of cotton-sown acreage in Burma follows:

BURMA COTTON SOWN ACREAGE AND COTTON LINT PRODUCED

Year	*Acres*	*Per cent of Prewar Acreage*	*Pounds of Cotton Lint*	*Per cent of Prewar Cotton Total*	*Pounds per acre of Cotton Lint*
1937–41	453,000	100%	45,800,000	100%	106
1938–39	408,000	90%	42,000,000	92%	103
1946–47	171,000	38%	8,720,000	19%	51
1947–48	222,000	49%	17,230,000	38%	78
1948–49	219,000	48%	17,230,000	38%	79
1949–50	216,000	48%	15,850,000	35%	73
1950–51	221,000	49%	17,230,000	38%	78
1951–52	255,000	56%	15,400,000	34%	61
1952–53	294,000	65%	20,600,000	45%	70

A primary consideration of the cotton lint to be used in indigenous production is quality. At the present time, over 80% of all Burma cotton is BCF, or Wagale, cotton. Due to the short $\frac{1}{2}$ in. to $\frac{5}{8}$ in. strand of this cotton, it cannot be utilized for spinning normally above a No. 12 count weaving yarn. This factor restricts its use considerably so that only a comparatively small proportion of all weaving cotton consumed in Burma can use Wagale as the basic material. Consequently, it is of the utmost necessity to develop increased acreages of Burma with a longer staple cotton that can be used to spin up to at least No. 20 count. If this can be accomplished, then eventually, 80 to 90% of all Burma cotton cloth and yarn can be produced from Burma cotton; and imported cotton textiles, as the largest single source of all imports, will be greatly reduced.

The volume and type of cotton that must be grown in Burma to make this country self-sufficient and eliminate imports has been previously reviewed. The next step to consider is the necessary implementation for the indigenous manufacture of textiles which Burma now consumes. On the following page is a chart based on the equipment required to produce the textiles currently consumed as well as those required in future years when Burma will be able to provide its people with 30 yards per person per year on a par with other countries.

(d) Justification. The production and availability of cotton textiles are basic in the provision of clothing, household articles, and industrial goods. Clothing alone will consume approximately 75% of all cotton goods produced and affects vitally the health and welfare of city, village and rural people alike.

(e) Importance of project in relation to Burma economic program. One of the major objectives of the economic development program is to utilize Burma's basic resources to increase her independence of imports. Prior to the war, Burma had an average of 450,000 acres of cotton producing an average of 45,800,000 pounds of cotton lint. Over 95% of this cotton was exported for a value of approximately K95 lakhs. In return, over K4·5 crores of finished cotton textiles and yarns were imported. The Burma economic program will plan to produce a large part of these textiles in Burma with the eventual implementation of the necessary spinning, weaving and finishing machines. These facilities will result in minimizing the import of cotton textiles and conserve foreign exchange expenditure. The difference in the value of the raw cotton and the finished textile will go to labor, factory and merchant within Burma rather than be expended on imports from abroad.

(f) Direct employment. The average cotton spinning factory composed of 20,000 spindles will require approximately 900 workers for three full shifts per day. This number includes both factory workers, clerical and office staff. The average 200-loom weaving plant will require about 125 workers for three full shifts. The average bleach and finish section handling ten million yards per year* and dye and print section handling five million yards per year* will require about 150 workers for three full shifts.

To produce the amount of cotton textiles currently consumed by Burma† would require approximately 5·2 spinning factories (for No. 20 count and under), 28·7 weaving mills, and about 13 finish and dye plants of the above indicated size. On a three-shift basis, the total workers and staff for all plants would amount to slightly over 10,000 people.

Skilled Workers. Almost all textile workers are obtained presently from the cottage industries. As there is estimated to be approximately 250,000 hand looms in Burma, it follows that there are a great

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* 24 hour day operation.

† Refer to "Burma Implementation Chart for Self Sufficiency," on Part C 1 (c).

BURMA IMPLEMENTATION CHART FOR TEXTILE SELF SUFFICIENCY

Total Cotton Textiles Consumed	*No. of Spinning Factories equivalent of present Government Spinning Factory[3] of 20,000 Spindles*		*Number of Weaving Mills 200 Loom[6] Size*	*Capacity of Bleach and Finish Facilities at 90% of all Yarn Consumed*	*Capacity of Dye and Printing facilities at 50% of all Yarn Consumed*
	To Spin all Textile Yarn Counts, 100% of all Yarn Consumed	*To Spin only Count No. 20 and under, about 80% of all Yarn Consumed*			
Current[1] Burma Textile Consumption at 8 yds/person/year 150,415,042 yds/year	6·4[4]	5·2 (inclusive of present factory)	28·7[7]	135,500,000 yds./year	75,207,521 yds./year
Burma Objective[2] Textile Consumption at 30 yds./person/year 555,000,000 yds./year	23·7[5]	19·0	105·5[8]	499,500,000 yds./year	277,500,000 yds./year

[1] Refer to "Total Annual Burma Cotton Cloth Yardage, 1951–52" on page L 152.

[2] Refer to "Consumption by Country of Cotton Piecegoods Per Person Per Year" on page L 152.

[3] Capacity rated at 4,675,000 lbs./year 2½ shifts (90,000 lbs./wk.) or 92% of absolute efficiency. (Note: If factories were operated with an extra fourth shift for 365 working days/yr. production would be increased approximately by 60%.).

[4] Refer to "Total Annual Consumption of Burma Cotton Cloth in Pounds Weight, 1951–52" on page L 155.
30,083,008 lbs. Tot. Cloth: 4,675,000 lbs. Govt. mill/yr. = 6·43 factories.

[5] 111,000,000 lbs. Tot. Cloth: 4,675,000 lbs. Govt. mill/yr. = 23·74 factories:

[6] Present accommodation of Govt. spinning and weaving factory.

[7] For present calculation, hand looms have been discounted. But machine looms are:
at 35 yds./loom/8 hrs. = 87·5 yds./loom 2½ shifts/day.
87·5 yds. x 300 working days/yr. = 26,250 yds./yr./2½ shift.
26,250 yds./yr. x 200 looms = 5,250,000 yds./yr. 200 looms.
150,415,042 yds./yr. total consumption: 5,250,000 = 28·65 Govt. mills.

[8] 555,000,000 yds./yr. total consumption: 5,250,000 = 105·5 Govt. mills.

number of people experienced in this work. The Burman is well adapted to mechanical work of this nature. An inexperienced man can do well with six months apprentice training in the mill.

For highly skilled workers of the administrative level, a good botanist and entomologist are needed for the agricultural research required in developing a longer staple of Burma cotton with a high yield per acre and which is healthy and fairly immune to insects and disease. A limited number of other skilled administrative workers are required such as experienced spinning, weaving, finishing, printing and dyeing experts.

(g) Foreign exchange conservation. The conservation of foreign exchange is one of the basic and most outstanding reasons for Burma to become self sufficient in the supply of textiles. For the year of 1950–51, Burma paid out almost K25 crores for imported cotton goods alone.

(h) Economic feasibility. The present period is not well adapted for immediate expansion in the field of cotton textiles especially in regard to spinning and weaving. A condition of overstocked cotton goods throughout world markets has resulted in a considerable decrease in both price and demand. Due to an unusually large USA crop and with India and Pakistan pressing for sales, the over-all world market for cotton dropped from K700 per bale in 1951 to a low of K395 per bale in 1952. Prices are increasing slowly, but the normal market probably will not fully return for another few years.

The Government cotton spinning and weaving factory at Thamaing is just recently commencing to show progress towards profitable operation. Its inception took place under extremely adverse conditions in the world cotton market. Many experienced and long-standing mills were forced to shut down or curtail operations in other countries. The Government spinning factory has been handicapped in the following ways:

(*1*) Labor difficulties within Government factory resulting in top-heavy labor costs and lowered efficiencies and standards.

(*2*) Inability of Government factory to weave higher than a No. 12 count* from 100% Burma cotton.

(*3*) Unstable cotton market and high prices paid for Burma cotton used.

* A limited amount of No. 16 count yarn is spun from a select portion of indigenous cotton, but this is not available in quantity.

(4) Lack of satisfactory or sufficient sales representation. (A separate, well-staffed sales office is required to sell the output of the spinning factory months in advance).

(5) Necessity of importing foreign cotton for mixtures capable of spinning higher than a No. 12 count.

(6) Excessive drop in over-all world cotton market with an oversupply of cotton.

(7) Necessity for cooperative and well designated authority within the plant to simplify administrative directives.

(8) Necessity for closer cooperation and contact between the Government spinning factory and the directors of the Government Agricultural Cotton Board toward developing and producing a longer staple indigenous cotton.

(9) Lack of a textile and agricultural laboratory for testing fibers both in raw cotton and in finished cloth. (All work must now be sent to Matunga Cotton Laboratory, Bombay).

(10) Facilities for finishing, dyeing and printing are completely lacking, and bleaching capacity is too limited (800 lbs. cloth).

(11) Facilities for doubling, or twisting, yarn is not available.

(12) Spinning machinery suitable for producing yarn up to No. 40 count only.

(13) Weaving of cloth is confined to widths commensurate with reed spaces of 50-inch on looms.

(14) Lack of advertising. Government factory is in competition with private mills and should advertise to encourage buying. (Many textile people have been unacquainted with Government mill products).

(i) Description and cost of plant. A cotton spinning and weaving factory comparable to the present Thamaing plant of 20,000 spindles and 200 looms would cost about K1,75,00,000 inclusive of machinery, buildings and installation to replace at the present time* The machinery would cost K1,25,00,000 installed, and the buildings are estimated at K50,00,000. The 200 looms would cost K12·5 lakhs installed as a separate unit, exclusive of building, but have been included in the above over-all price.

A bleach, finish, dye and print plant composed of facilities for handling ten million yards per year† in bleach and finish section and five million yards per year in dye and print section† will cost K20 lakhs, installed in Burma inclusive of drainage, foundations and buildings.

(j) Raw material cost. The price of lint cotton purchased in bales for the Government spinning factory is as follows:

Price of Cotton Lint, 1952:

K1.95/lb.—½ in. staple, Wagale, Burma Cotton
K2.20/lb.—¾ in. staple, M3, Burma Cotton
K2.14/lb.—⅞ in. staple, American Cotton
K2.20/lb.—⅞ in. staple, L.S.S., Pa.

Price of Cotton Lint, 1953:

K1.10/lb.—½ in. staple, Wagale, Burma Cotton
K1.25/lb.—¾ in. staple, M3 and M5, Burma Cotton
K2.00/lb.—⅞ in. staple, American Cotton

The price of cotton yarn sold by the spinning section of the Government factory, and which is used also by the weaving section, is as follows:

Selling Prices of Government spinning factory yarn

K1.70/lb.—No. 5 count weaving yarn.
K2.40/lb.—No. 10 count weaving yarn.
K2.50/lb.—No. 16 count weaving yarn.
K2.60/lb.—No. 20 count weaving yarn.

(k) Production cost and earnings. The production cost of No. 10 count yarn should be as follows:

Item	*K/lb*	*Per cent of Total Cost*
Wagale Burma Cotton	K1·100	50·5%
Direct Labor	K0·263	12·1%
Overhead and General Labor	K0·817	37·4%
Total Cost Price	K2·180	100·0%

The selling price is K2.40 per pound; therefore the profit is equal to K0.22 per pound of yarn, or about 10% of the cost price.

In recent years, however, both the cost price of Wagale cotton and the general labor and overhead have been excessive. This has resulted in eliminating what otherwise would have been profit for operational investment. In the last six months, much of this overhead has been reduced, and cotton prices are tending also to return to more normal figures. With continued improvement in operating efficiencies, the Government spinning factory stands to make a much improved showing for the year 1953–54.

Of course, Burma will be unable to grow all the types of cotton needed to weave the piecegoods that are now imported. For the manufacture of the higher counts of cotton, possibly above No. 22 or No. 30 count, cotton will always have to be imported. But other competing countries such as India, Japan and the UK must also import their cotton from Egypt and America for these higher counts. This fact places their competition on much the same footing as Burma. And with increased efficiencies, the Government mills of Burma will be able to meet favorably this competition when it is later necessary. For indigenous consumption, the privately operated Burma weaving factories have been profitably importing the high count yarns for some years. Whether it is possible to export profitably the cloth woven from imported yarns is another question. This would place Burma in direct competition with such worldwide textile leaders as India, Japan and even the UK. At the present time, the textile industry in Burma is not sufficiently aged or experienced to qualify for such competition, nor is it necessary with the present undeveloped and unexpanded condition of the indigenous market.

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* Not including land.

† Operating 24 hrs./day at 300 days per year.

(l) Existing production facilities. The Government spinning factory at Kamayut has 70 frames totaling 20,160 spindles at 288 spindles to the frame. This is the only active spinning factory presently in Burma* and its maximum capacity is rated at 4,675,000 lbs. per year per 2½ shifts at 92% of absolute efficiency.

In regard to weaving equipment, it is estimated that there are approximately 400 power looms: 200 are in the Government spinning and weaving factory and the remaining number are divided among about six factories in the Rangoon area with only a few in Mandalay. The output of the average powerloom is between 30–35 yds. per eight-hour day. As most powerlooms are now operated on a 2½ shift day, the output per loom per year of 300 operating days is 26,250 yards.† For 400 looms, this totals 10,500,000 yds. per year.

The output of the average hand loom is estimated at six yds. per eight-hour day. Out of the 250,000 handlooms in Burma, it is estimated that only 60,000 are in use owing to present conditions of poor communication and difficulty in obtaining the right type of yarn and labor. Much handloom operation is seasonal for periods of non-agricultural activity where the operator will work in the fields for planting and harvest and then operate his loom when not otherwise occupied.

There is a definite scarcity of textile bleaching, finishing, dyeing and print works in Burma. For bleaching and finishing, a few of the larger textile mills have their own facilities, but there are far too few to service the greater amount of cloth required. Consequently, most handloom products are not finished and are sold at much lower prices than similar quality cloth that has been finished at little additional expense. Cloth dyeing is often handled by either the finishing plant or printing establishment. Yarn is often dyed by the handloom operators themselves. Most dyeing is poor both in respect to colors and finish. There is an urgent need for training printers and dyers, and a technical dye chemist is needed.

There are less than 100 printing establishments in Burma. About 80 handwork printing shops are in Rangoon, but, with the exception of a few semi-mechanized plants, all work is done by hand. Each table of handblock printing can turn out 150 yards per day. The largest printing works in Burma uses wooden rollers and is in Mandalay. This shop turns out approximately 3,000 yds. per day, or 900,000 yds. per year of printed material using Azo dyes.

(m) Recommendations. Burma can absorb another four cotton spinning mills of a size equivalent to the present Government spinning factory. It is debatable as to whether the size should be smaller or larger than the present plant. As a larger plant is more economical to operate, it may be advantageous to establish a twin to the present 20,000-spindle plant in the Mandalay or Myingyan area. This plant will be so designed that an additional 20,000-spindle plant can be annexed to it at will. The size of the plant will be determined in part by the availability of workers, access to the market, shipment of raw materials, and finally by the economics of the world cotton market.

At the present time, the world textile markets are overstocked and raw cotton has been selling at a comparatively high price while cotton goods have been selling at a low price. This factor, coupled with unsettled labor conditions, lack of established plant routine, lack of buyer's market, and need for continued development of a longer staple indigenous cotton, make it inadvisable to consider a second plant while the first plant has been unable to satisfactorily circumvent or bridge such difficulties. This coming year may find many improvements in operational routine and if sales and production efficiency are on the way to establishing a plant of beneficial economic returns, then the construction of further spinning mills can be profitably considered. In another five years, however, the present plant will have provided indispensable experience and the other plants to follow will be able to benefit materially and financially by this pioneering.

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* The Violin Hosiery Works at Insein has 5,000 spindles used mostly for producing "knitting" yarns which are different from the "weaving" yarns spun by the Government factory. These spindles are not now in continuous active use.

† At 35 yds. per loom per eight-hour day.

With the consideration of the second and third spinning factory being located in the Mandalay district, the fourth plant can be annexed as an additional section to the existing Thamaing plant in Rangoon. If a fifth plant is still later considered, it can either again be added to the existing Thamaing plant or it might be located in the Moulmein area. The Thamaing plant is so located and designed that there is sufficient space and facility for expansion.

In regard to weaving mills, the average total annual consumption of cotton piecegoods in Burma is slightly over fifteen million yards per year. To replace this entire amount would require about 28 weaving factories of about 200 looms each*. The total amount of cotton piecegoods imported for 1951–52 was 68,921,212 yards. If the capacity of 200 looms is 5,250,000 yds./year per 2½ shifts, then these imports would require the work of 13·1 such 200-loom plants.

Imports of cotton goods for the year of 1950–51 were much heavier, being almost twice as great or 122,307,680 yards, which would require the work of 23·3 such 200-loom plants.

At the present time, there are only about 400 powerlooms in Burma which together would form the equivalent of two plants at 200 looms each. The remainder of the indigenous supply of cloth comes from Burma's estimated 250,000 handlooms which can each produce six yds. per eight-hour day, although only a fraction of these looms are producing. The handloom fits well into the economy of the country at the present time. It provides additional income for many rural families between the harvesting periods of their crops which is often their principal livelihood. But with open competition, the handloom cannot compete with the inexpensive machine-made cloths and still continue to pay its operators a living wage. At the present time the indigenous production of cloth is protected by certain import regulations levied against foreign machine-made goods. But this is an artificial temporary protection at its best, and when indigenous machine-made goods can compete successfully without this tax, the living cost of the people will be greatly reduced as clothing is a necessity used by everyone. India, Japan and the UK import much of their raw cotton the same as Burma and they can still ship their products often thousands of miles to Burma and undersell the indigenous market here. Raising the tariff rates will not lower the price of cloth. The textile industry in Burma is just starting, but eventually it will be able to meet foreign competition on an equal footing. In the meantime, much experience and wide adaptation to the many complexities of textile production is being effected. The handloom will fit somewhat into the picture of present high cost production, but if the economies of the machine-loom are mastered and foreign competition is evenly met, the resulting price of textiles, household materials, and clothing will play an important part in reducing the present exorbitant living costs. With the efficient installation of the necessary machinelooms, the handlooms will be too costly to operate with the exception of the better artcraft of ornate and unusual patterns.

The current season, however, is hardly the time to institute machineloom factories in the Burma economy. For the past few years, the world cotton market has been greatly overstocked and oversupplied with the result that prices have been reduced to a minimum. Other countries with far greater textile experience have been forced to curtail the operations of their plants. The private machineloom industries in Burma have also been reduced in their operations, although a few have as much business as they can handle. The Government weaving factory at Thamaing is operating at only one-third capacity due to lack of orders. When the buying market returns more to normal for cotton piecegoods and the present Government weaving factory has improved the efficiencies of its operation, and can meet competing prices, and has stocked a healthy log of orders through an expanded sales department, then the installation of further machineloom plants can be considered. With this in mind, it is recommended that a 200-loom weaving plant be later added alongside of the present Government weaving factory at Thamaing. Later, the districts of Mandalay, Moulmein and Akyab will qualify for consideration as possible machineloom locations.

A bleach, finish, dye and print section is recommended currently for annexation to the Government spinning and weaving factory at Thamaing. This section should have a capacity for the following:

Bleach Section†	—10,000,000 yds./yr. (33,300 yds. per 24-hr. day)
Finish Section	—10,000,000 yds./yr. (33,300 yds. per 24-hr. day).
Dye Section	— 5,000,000 yds./yr. (16,600 yds. per 24-hr. day).

The output of the present 200 looms at the Government factory is 5,250,000 yds. per year per 2½ shift capacity. This amount is just about half the capacity of the bleach and finish sections, although yarn from the spinning factory will also be processed here.

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* The size of the present Government weaving factory at Thamaing.

† Production of all sections is for 24-hr./day operation.

TABLE OF COTTON TEXTILE IMPORTS–EXPORTS

COTTON PIECEGOODS (COLORED, PRINTED OR DYED)

Year	*Imports*			*Exports*		
	Quantity	*Value*		*Quantity*	*Value*	
	Yards	*Per Yd. K*	*Total K*	*Yards*	*Per Yd. K*	*Total K*
1936–37	79,083,937	0.21	1,72,29,628	399,719	0.25	103,359
1937–38	93,889,127	0.23	2,18,94,446	5,903	0.36	2,136
1938–39	74,519,952	0.22	1,68,23,447	7,454	0.33	2,510
1939–40	101,059,930	0.22	2,32,08,618	947	0.86	815
1940–41	98,421,326	0.26	2,60,46,688	5,910	0.48	2,870
1945–46	5,529,319	1.56	86,58,757	nil	nil	nil
1946–47	5,864,265	1.58	93,20,979	nil	nil	nil
1947–48	43,494,536	1.46	6,37,41,919	12	5.83	70
1948–49	15,228,351	1.59	2,42,72,971	nil	nil	nil
1949–50	54,363,849	1.21	6,60,04,793	N.A.	N.A.	N.A.
1950–51	51,522,407	2.14	11,03,76,498	N.A.	N.A.	N.A.
1951–52	27,899,655	1.61	4,49,28,384	N.A.	N.A.	N.A.

N.A.=Not available.

COTTON PIECEGOODS (UNDYED)

Year	*Imports*			*Exports*		
	Quantity	*Value*		*Quantity*	*Value*	
	Yards	*Per Yd. K*	*Total K*	*Yards*	*Per Yd. K*	*Total K*
1936–37	80,789,703	0.20	1,61,63,977	208,650	0.22	45,[illegible]15
1937–38	76,610,646	0.22	1,70,51,067	nil	nil	nil
1938–39	63,091,287	0.19	1,24,21,696	1,600	0.25	400
1939–40	77,829,430	0.19	1,48,43,781	nil	nil	nil
1940–41	75,077,220	0.21	1,56,67,456	nil	nil	nil
1945–46	3,750,618	1.18	44,44,172	nil	nil	nil
1946–47	24,249,265	0.92	2,25,47,141	nil	nil	nil
1947–48	30,273,896	1.16	3,53,11,854	nil	nil	nil
1948–49	7,357,936	1.23	90,73,295	nil	nil	nil
1949–50	15,478,504	0.88	1,37,00,157	N.A.	N.A.	N.A.
1950–51	70,785,273	1.31	9,31,30,410	N.A.	N.A.	N.A.
1951–52	41,022,057	1.00	4,11,78,556	N.A.	N.A.	N.A.

N.A.=Not available.

COTTON TWIST AND YARN

Year	*Imports*				*Exports*		
	Quantity		*Value*		*Quantity*	*Value*	
	Tons	*Pounds*	*Per lb. K*	*Total K*	*Pounds*	*Per lb. K*	*Total K*
1936–37	5,548	12,429,449	0.50	62,70,770	42,380	1.18	50,010
1937–38	5,146	11,529,069	0.58	67,49,680	nil	nil	nil
1938–39	7,380	16,564,275	0.60	1,00,86,110	nil	nil	nil
1939–40	9,960	22,328,452	0.55	1,23,32,443	nil	nil	nil
1940–41	21,100	47,404,983	0.53	2,53,32,895	374,850	0.45	188,724
1945–46	nil	nil	nil	nil	nil	nil	nil
1946–47	386	86,713	4.13	3,58,210	nil	nil	nil
1947–48	1,350	3,034,590	2.53	76,87,848	nil	nil	nil
1948–49	2,440	5,484,524	2.81	1,54,43,068	nil	nil	nil
1949–50*	5,680	12,704,966	3.45	4,38,92,543	N.A.	N.A.	N.A.
1950–51	3,900	8,739,197	4.87	4,26,02,023	N.A.	N.A.	N.A.
1951–52	6,120	13,698,666	7.95	10,89,20,982	N.A.	N.A.	N.A.

Government imports excluded. N.A.=Not available.

* Figures for 1949-50 includes cotton thread also.

RAW COTTON

IMPORTS

Year	*Quantity*		*Value*	
	Tons	*lbs.*	*Per lb. K*	*Total K*
1936–37	3	6,720	0.20	1,345
1937–38	2	4,480	0.21	977
1938–39	4	8,960	0.14	1,260
1939–40	10	22,400	0.12	2,872
1940–41	84	188,160	0.20	39,434
1945–46	nil	N.A.	N.A.	181
1946–47	1,114	2,495,360	0.63	15,85,937
1947–48	5,103	11,430,720	0.67	76,63,222
1948–49	nil	N.A.	N.A.	34
1949–50	34	76,160	0.94	71,650
1950–51	519	1,162,560	1.95	22,72,042
1951–52	1,838·4	4,118,016	1.97	81,36,471

N.A.=Not available.

EXPORTS

Year	*Quantity*			*Value*	
	Tons	*lbs.*	*Bales at 400 lbs. each*	*Per lb. K*	*Total K*
1936–37	23,455	52,539,200	128,138	0.24	1,26,96,505
1937–38	18,606	41,677,440	104,211	0.21	88,10,000
1938–39	16,648	37,291,520	93,257	0.20	75,43,955
1939–40	17,979	40,272,960	100,659	0.25	1,02,23,068
1940–41	16,579	37,136,960	92,811	0.21	78,70,324
1945–46	nil	nil	nil	nil	nil
1946–47	2,389	5,351,360	13,320	1.10	59,15,513
1947–48	9,572	21,441,280	61,885	0.97	2,08,11,581
1948–49	4,276	9,578,240	676,723	0.75	72,42,372
1949–50	N.A.	N.A.	N.A.	N.A.	N.A.
1950–51	N.A.	N.A.	N.A.	N.A.	N.A.
1951–52	N.A.	N.A.	N.A.	N.A.	N.A.

N.A.=Not available.

This finish and dye plant is not meant to service all of Burma's needs. Its capacity is insufficient for this, of course, but large quantities of grey (unbleached) yarn and cloth that are both imported or manufactured in Burma can be processed here. Silk, rayon and wool goods can also be treated in some instances. Later, a second plant of the same size can be considered for the Mandalay district. The finishing process can often increase the value of the textile by 50% and only a relatively small expense is required by the processing.

(9a) Silk and Silk Products

(a) **The market.** During 1950–52 Burma imported silk products in the amounts and of values shown in the following table:

	Quantity	*Value - K*
1950–51		
Raw Silk	146,548 lbs.	11,78,134
Silk Thread and Yarn	239,103 lbs.	21,31,818
All Woven Silk Materials	108,660 yds.	2,71,874
		35,81,826
1951–52		
Raw Silk	96,180 lbs.	8,61,621
Silk Thread and Yarn	196,947 lbs.	4,62,300
All Woven Silk Materials	42,771 yds.	1,02,962
		14,26,883

The following table of silk imports for Burma and other countries shows that the volume of silk imported by Burma has exceeded that of Thailand, Indo-China and Indonesia, and is approximately half as much as the silk imported by India and Pakistan with their 450,000,000 people.

SILK TEXTILE IMPORTS

In metric tons

Year	*Burma*	*Thailand*	*Indo-China*	*Indonesia*	*India and Pakistan*	*Italy*
1936	—	20	47	56	910	288
1937	436	20	47	56	910	288
1938	436	20	47	56	910	288
1939–46	—	—	—	—	—	—
1947	*54	2	32	—	287	92
1948	*105	3	107	—	837	88
1949	133	6	6	6	52	145
1950	172	8	*14	*1	311	300

* Estimated figures.

There is a substantial domestic and foreign market for silk thread, yarn and fabrics, that can be supplied by the rehabilitation and expansion of the silk industry in Burma. The economic aspects of the industry are particularly favorable since it can be developed on a rather widespread cottage industry basis, with small capital outlay. It will provide employment for a large number of people in areas where employment opportunities are now limited. Steps in the rehabilitation of the silk industry have been undertaken.

(b) Possibility of domestic production.

(1) *General*

At the present time much of the silk yarn is imported from Japan, although Chinese silk is preferred. The climatic conditions in parts of Burma are favorable to the cultivation of mulberry trees and silk worms. One acre of mulberry will produce about 500 pounds of cocoons or 45 pounds of raw silk†.

The areas most suitable for the silk industry are the Myitkyina district, Chin Hills, Prome district, Toungoo district, Maymyo, Lashio, Kutkai, Kalaw, Taunggyi, Loikaw and Loilam. The Burma groups best suited to sericulture are the Yebeins, Karens, Kachins, Chins, Shan-Burmans and Nepalese. These people have been developing sericulture since prewar days. The various phases of the silk industry require many manual operations that cannot be accomplished entirely by machine. An inexpensive labor supply is therefore a pre-requisite to economical operations. The wages of the silk weaver usually are affected somewhat by the seasons. Wages for six months of the year are normal; for three months are good, and for the three remaining months are poor. During the three "poor" months, the weaver will weave about two yards of silk a day and will receive about K2.50 Each loom will weave about five viss of yarn a month, enough material for about 30 longyis. The labor involved is paid about K45 for weaving one viss of silk.

(2) *Phases of the silk industry*

(*a*) *Production and utilization.* The silk industry is divided into two main phases, production and utilization. "Production," or sericulture, includes the systematic cultivation of mulberry plants, bushes and trees, and the scientific rearing of silk worms. The second phase, "utilization", includes the reeling of cocoons, silk spinning, silk throwing, silk dyeing and silk weaving.

(*b*) *Silk Manufacture.* 1. *Quality of Cocoons.* The cocoons are divided into 4 qualities as follows: *a.* Cocoons clean and firm; *b.* Cocoons, otherwise good, but stained by crushed cocoons; *c.* Weak cocoons; *d.* Cocoons crushed and badly stained from within.

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† About 9 lbs. silk per 100 lbs. of cocoons.

2. *Reeling.* Reeled silk is known as raw silk, and the object is to bring together two or more, generally from 5 to 20 cocoons and to form them into continuous, uniform, and regular strands, known as raw silk. Reeling is carried out in a "filature" which consists of 20 to 300 reeling basins. Female labor is usually required as the work is extremely delicate. Filatures are constructed to enable four, six, to eight skeins to be reeled by one reeler at a time. Thread breakage is not a problem as good silk will stretch one third of its own length before breaking.

3. *Throwing.* Throwing is the operation of twisting and doubling raw silk into more substantial yarn. This is the least skilled operation in the manufacture of silk and may be performed by inexpensive unskilled labor.

4. *Weaving.* The types of looms are similar to those used for other textiles. There are the three types; plain, box, and jacquard. The plain loom weaves flat fabrics such as taffetas and linings. The box loom weaves the crepes and novelties. The jacquard loom is an intricate mechanism and weaves elaborate designs for damasks, brocades and lame.

5. *Degumming.* Degumming is done as part of the dyeing and finishing operation to remove the natural gum or coating of albuminous matter which is part of the filament spun from the cocoon.

6. *Spinning of silk waste.* Silk waste is silk unsuited for the throwing process. The silk "throwster" takes the perfect thread and the silk-waste spinner takes the imperfect thread.

(c) Recommendations. Such phases of the silk industry as the establishment of mulberry plantations, silk worm rearing, organization of cocoon markets and silk weaving are now being carried out under the direction of the Superintendent of Cottage Industries assisted by UN experts. The most important consideration along industrial lines is the need for a central filature or silk reeling mill. When reeling is done by the rearers themselves, the quality of the thread is usually poor, and a large portion of the silk is left as waste. A central filature will produce a high uniformity and continuity of each thread for the benefit of the rearer and of the trade. Crude home-made machines cannot do this.

Installation of a silk reeling mill with a capacity of 575 pounds silk output per day, or 172,500 pounds a year, is recommended. This is slightly less than the poundage of silk thread and yarn imports for 1951–52. A plant of this capacity will cost about K4,00,000 and is believed sufficiently large for the preliminary step in the industrialization of the silk industry.

(9b) Rayon and Rayon Products

(a) The market. Artificial silks are extensively used in Burma. The value of imported artificial silk manufacture reached the considerable amount of almost K3,00,00,000 for the year 1951–52. The import-export data do not differentiate between rayon and other artificial silks such as nylon. As rayon is the lower priced material and because the average cost per yard of all imported artificial silk manufactured was K1 per yard, it is evident that by far the greater proportion of imports were rayon.

Rayon is a strong competitor of cotton, silk and nylon. Some of its most popular uses are the following:

General Types of Finished Goods Using Rayon

(1) *General Uses.* (*a*) Rayon canvas for tennis shoes, rubber soled shoes. (*b*) Linings for trunks, suitcases, shoes. (*c*) Umbrellas, ribbons, fringes, braids, labels, bindings.

(2) *Industrial.* (*a*) Rayon cord for automobile tires, automobile upholstery.

(3) *Men's and boy's wear* (*a*) Jackets, underclothes, sport shirts, shirts, socks, trousers, longyis. (*b*) Suit linings, coat linings, hats, gloves, ties.

(4) *Women's and children's apparel.* Longyis, dresses, underwear, hosiery, linings, sweaters.

(5) *Household uses.* Curtains, bedspreads, draperies, upholsteries, quilts, blankets.

The use of rayon has increased where it is used as a crossweave with cotton in weaving cloth. The Government cotton spinning and weaving factory would often prefer to use rayon to weave with indigenous cotton as it is 100% usable, whereas approximately 10% of imported cotton must be discarded as waste. For automobile tire cord bodies rayon is greatly superior to cotton due to its ability to increase in strength and elasticity with heat. If automobile tires are manufactured in Burma, the availability of rayon would be advantageous. Where rayon is used as a substitute for silk or nylon, its popularity is decreasing. Rayon will not stand repeated washings and wear like silk, nylon or cotton.

(b) Possibility of domestic production

(1) *Raw materials*

The essential raw materials required in the production of rayon are cellulose materials. Burma is in a favorable position insofar as most indigenous raw materials are concerned. Not only is cotton the purest form of cellulose available, but also other cellulose materials such as bamboo, bagasse, reeds, and hard and soft woods are available in abundance.

Much work has been done in India on the processing of these materials to provide a suitable rayon pulp. A pilot plant to test such materials and convert them into rayon pulp on a semi-commercial scale has been established.

The raw materials and amounts required per pound of viscose process rayon yarn are as follows:

Raw Materials Required per Pound of Viscose Rayon

1.	1·15 to 1·25 lbs.	Wood pulp and cotton
2.	1·4 lbs.	Caustic soda
3.	0·35 lbs.	Carbon bisulphide
4.	1·7 to 1·9 lbs.	Sulphuric acid
5.	0·5 lbs.	Glucose
6.	0·4 lbs.	All other chemicals
7.	100 to 200 gallons	Pure soft water

The above figures represent the gross consumption and do not show recovery of chemicals or materials.

The manufacture of carbon bisulphide should take place at the rayon plant site, as this chemical is highly inflammable and dangerous to transport. Sulphuric acid could be manufactured at the plant site, if it is not available within economical transportation distance of the plant. Caustic soda is an important chemical, and a rayon plant located near a caustic soda plant would be an advantage, as it could purchase its caustic soda in liquid form, thus saving the cost of concentrating, and later on, dissolving the caustic. The other chemicals required for the manufacture of viscose rayon are only of minor importance, as the quantities are small.

(b) *Cost of plant*

The table below shows the estimated cost of three sizes of plants for the manufacture of rayon yarn by the viscose process. The capacities of these plants are 750, 1,500 and 3,000 tons of yarn per year. The present imports of artificial silk products of all types are estimated at 1,250 tons per year. The estimate does not include a weaving plant to produce rayon cloth from the yarn. The costs are given in rupees (Indian) as they are based on the costs of an installation to be built in that country.

(c) **Recommendations.** While the present consumption of artificial silk products in Burma is large enough to justify the construction of a rayon plant of possibly 1,500 tons per year, this is not an essential industry, and should be deferred for inclusion in a long range plan, or until the basic industries are completed and are in successful operation.

(9c) Wool Textiles

Burma, prior to the World War II, produced a substantial quantity of raw wool, but exported most of it. The postwar production is far below the prewar rate, due to the loss of a large number of edible animals during the war. Some raw wool has been imported, but the quantity is very small, with none recorded in the last four years. The following table shows these figures.

ESTIMATED CONSTRUCTION COST
RAYON YARN MANUFACTURING PLANTS

I. Capitalization	*(750 tons/yr.)* *2·5 tons/day*	*(1,500 tons/yr.)* *5 tons/day*	*(3,000 tons/yr.)* *10 tons/day*
	Rs.	Rs.	Rs.
(*a*) Land and Buildings	28,78,000	28,78,000	42,53,000
(*b*) Machinery and Equipment	89,50,000	1,59,80,000	2,95,81,000
(*c*) Erection and Starting	11,40,000	16,34,000	23,10,000
(*d*) Working Capital	6,30,000	12,60,000	25,20,000
Total Capitalization	1,35,98,000 (cost = 35% of 10 ton/day plant)	2,17,52,000 (cost = 56% of 10 ton/day plant)	3,86,64,000 (100%)
II. Production Cost	*2·5 tons/day*	*5 tons/day*	*10 tons/day*
	annas	annas	annas
(*a*) Raw Materials and Chemicals	10·18	10·18	10·18
(*b*) Labor and Supervision	1·81	1·37	1·02
(*c*) Power, Fuel, and Water	2·40	2·11	2·11
(*d*) Maintenance and Supplies	1·35	1·10	1·10
(*e*) Depreciation	4·70	4·11	3·98
(*f*) Miscellaneous	·20	·10	·10
Total Cost per lb. of Rayon Yarn	20·64 = Rs. 1/4/8	18·97 = Rs. 1/2/11	18·49 = Rs. 1/2/6

Above figures include the following items:

Land, Buildings and all Construction Work
Main Process Plant
Auxiliary Equipment
Steam-Power Plant
Water Plant
Carbon Bisulphide Plant
Sulphuric Acid Plant
Warehouses, Workshops, Garages, Office Buildings and Living Quarters for Engineers.

RAW WOOL

Year	*Imports*			*Exports*		
	Quantity	*Value*		*Quantity*	*Value*	
	lbs.	*Per lb.* *K*	*Total* *K*	*lbs.*	*Per lb.* *K*	*Total* *K*
1936–37	179	3.07	551	297,121	0.29	88,460
1937–38	874	0.52	457	176,747	0.40	71,194
1938–39	1,140	0.26	300	244,857	0.24	60,855
1939–40	—		—	280,262	0.32	93,340
1940–41	—		—	189,006	0.59	1,13,223
1945–46	—	—	—	—	—	—
1946–47	41	6.46	265	20,160	0·26	5,400
1947–48	7	11.28	79	—		
1948–49	—		—	59,578	1.04	62,249
1949–50	—		—	N.A.		N.A.
1950–51	—		—	N.A.		N.A.
1951–52	—		—	N.A.		N.A.

N.A. = Not available.

Burma imports wool thread and exports none. These figures are shown below.

WOOL THREAD YARN

Year	Imports			Exports		
	Quantity	Value		Quantity	Value	
	lbs.	Per lb. K	Total K	lbs.	Per lb. K	Total K
1936–37	61,635	2.00	1,23,557			
1937–38	215,813	1.46	3,15,690			
1938–39	171,182	1.75	3,01,133			
1939–40	347,233	1.41	4,91,540			
1940–41	117,489	3.33	3,91,487			
1945–46	1,286	6.89	8,868			
1946–47	11,828	7.44	88,095			
1947–48	69,291	8.29	5,74,839			
1948–49	54,957	8.72	4,79,692			
1949–50	88,183	8.35	7,36,768	N.A.		N.A.
1950–51	133,109	11.91	15,86,553	N.A.		N.A.
1951–52	333,252	7.87	26,23,913	N.A.		N.A.

N.A. = Not available.

Burma also imports wool products, mostly in the form of wool carpets and rugs. She formerly exported some carpets and rugs but has not done so since the war. The following table shows these imports.

WOOL CARPETS AND FLOOR RUGS

Year	Imports			Exports		
	Quantity	Value		Quantity	Value	
	lbs.	Per lb. K	Total K	lbs.	Per lb. K	Total K
1936–37	50,659	1.97	99,954	237	1.48	351
1937–38	87,630	2.46	2,15,653	229	4.34	995
1938–39	83,179	1.66	1,38,130	—		—
1939–40	81,531	2.30	1,88,137	—		—
1940–41	84,173	1.73	1,46,338	400	0.60	240
1945–46	29,830	2.71	80,876	—		—
1946–47	132,770	2.99	3,97,024	—		—
1947–48	76,117	1.69	1,28,943	—		—
1948–49	39,952	0.48	19,352	—		—
1949–50	15,644	1.01	15,945	N.A.		N.A.
1950–51	5,480	6.47	35,497	N.A.		N.A.
1951–52	54,856	8.95	4,91,246	N.A.		N.A.

N.A. = Not available.

The wool products manufactured in Burma from imported wool thread are made in cottage-industry-sized plants. This is principally cloth for clothing. The Cottage Industry Division is considering establishing a new wool cloth weaving industry at Natmauk where wool is produced.

(a) Recommendation. The principal need seems to be for the establishment of raw wool processing plants to produce wool thread. Dyeing plants should be a part of this industry. For the near future this should be kept on a cottage industry basis. Rug and carpet weaving should follow to eliminate the importation of such products.

(10) Meat Packing

At the present time there is no organized meat packing industry in Burma. This is partially due to the eating habits of the people and partly due to World War II during which a large part of the nation's stock was lost. Burma also lacks the necessary facilities for storing and conserving meat products. Consequently, little slaughtering of cattle is done in Burma. Some pork and mutton are available.

The Government is conscious of the lack of cattle in the country and is taking steps to increase the quantity and quality. A cattle breeding center near Magwe has been established and is beginning to show results. The preferred breed of cattle in Burma is not primarily beef stock, but is work stock used for pulling carts and farm implements. Water buffalo are also used for these dual purposes.

Very little meat or meat products are imported. The prewar records disclose that the average prewar import of meat and meat products was only 35,000 cwt. Since the war, this has decreased. The 1951–52 year imports totaled only 1,400 cwt. There is therefore no need to build up a meat packing industry to eliminate imports. The principal need is to improve the diet of the people. As the people of Burma are not basically meat eaters the industry may never reach an important status.

However, the meat offered on the market is poorly prepared and poorly handled. Almost all meat sold is fresh slaughtered as there are no cold storage plants to preserve it properly. The need for a meat packing industry will depend on the growth of the demand for meat products, and the increase in meat animals available for sale. Following this, a refrigerated distribution system must be established. The nation had such a system at the end of the war, when the Allied Armies left complete operable refrigerated cars and barges. Through disuse these facilities deteriorated and were junked.

Any modern slaughter houses and packing plants should be located near the cattle raising areas. Any new plants should be small, but expandable, and should include one or more cold storage plants and refrigerated cars. A 50,000-pound-per-day meat processing and storage plant would handle 1,400 sheep, 119 cattle, and 140 hogs in eight hours. A 170-ton capacity cold storage plant is a necessary part of the unit. A complete plant of this type will cost approximately K91,55,000. Such a plant should be constructed when the meat animals become available.

(11) Dairy Products

The people of Burma consume little milk and dairy products. The climate is not favorable to the preservation of such products. Almost all nationally produced milk is consumed as produced and practically none is processed. No modern creameries exist.

The cattle bred in Burma are principally work animals and produce only a limited supply of milk. Cows' milk is supplemented by water buffalo and goat milk. Few of the milk animals are tubercular tested and no modern dairies exist. Recently however, the Government has established a modern dairy farm near Rangoon as a demonstration project to encourage dairy farming.

Because of the limited quantity of milk produced in Burma, means for collecting and processing it have not been developed. Imported milk in evaporated or powdered form is used to supplement the indigenous supply of fresh milk. Imports of these products total about 150,000 cwt. per year. The most recent declared import values of such products average K70·6 per cwt., so that the present annual expenditures of foreign exchange total approximately K1,06,35,000 per year. These figures do not include butter and cheese.

The estimated average consumption of milk per capita in Burma is about 8·18 kilograms (18 pounds). This is equivalent to less than four imperial quarts per year, an extremely low average. There is no reason why Burma cannot produce her entire requirements of milk and dairy products. The industry must begin with building up dairy herds near the larger cities and towns and growing suitable food for them. This step will require several years. With it must grow a modern milk collecting and processing system. Initially only pasteurizing, bottling and butter making facilities would be required in the processing plant, at least until the supply of fresh milk exceeds the demand. When a surplus of fresh milk becomes available, the processing plant should be expanded to include facilities for making evaporated and powdered milk for distribution to areas where refrigeration is not available. This industry would be especially suitable for private development. To save transportation costs, it would be most economical to have the farms and plants located near the urban centers in which they will have their markets. The most expeditious means of augmenting the present low milk production in Burma is to manufacture a milk substitute as outlined in the following paragraphs.

(11a) Soya Products

One of the valuable farm products that may be successfully and profitably grown in Burma is soya beans. Its value lies in the fact that it may be used directly as a food and that it may be processed into other food and industrial products.

One of the principal manufactured products is a milk substitute called Soyalac. Soyalac is a palatable product entirely free from any objectionable soya bean taste. This milk substitute has excellent keeping qualities and does not deteriorate if properly packed.

Its production in Burma is warranted for several reasons. One is that the Burmese diet is deficient in milk, being only about nine pounds per year per person (about four imperial quarts). A second reason is that Burma does not produce her requirements of milk, as the average annual imports total about 150,000 cwt. valued for import purposes at K1,06,35,000. A third reason is that the production of soya beans for soyalac would provide a new market for this agricultural crop that would increase the national income and employment. A plant or plants to manufacture Soyalac would meet the objectives of the development program in every respect. Milk from this source could be made available much quicker than from the long process of building up a dairy industry.

The analysis of Soyalac proves that it has the same relative quantities of protein, carbohydrates, fats, minerals and vitamins as natural milk. The process is simple, requiring only a few technicians. The powdered and evaporated milk imported is equivalent to 19,000,000 quarts of natural milk per year. There is therefore no doubt of a market outlet for any national milk produced.

A single initial plant having a daily capacity of 20,000 quarts per day would produce 6,000,000 imperial quarts per year on a 300-day year operation. Such a plant would displace about one third of the annual imports of these milk products. It is estimated that a Soyalac plant of this capacity would cost a total of K29,40,108.

The manufacturing cost is estimated to be as follows:

	Annual Cost	*Cost per Quart**	*Cost per Pint**
	K	*K*	*K*
Raw Materials	21,95,400		
Processing	9,39,000		
Packaging	18,00,000		
Distribution	72,000		
	50.06,400	0·8344	0·4172

* Imperial measure.

It is necessary to assume a selling price, as no sales of Soyalac have been made in Burma. For estimating purposes a price of K0.55 per imperial pint has been selected. This is a lower price than that of the milk equivalent of condensed milk sold in Burma and is much lower than that of other milk sold at retail.

On this basis, the profits on the investment of K29,40,108 would be as follows:

	K	Per Quart K	Per Pint K
Gross Sales	66,00,000	1·1000	0·5500
Cost of Sales	50,06,400	0·8344	0·4172
Gross Profit	15,93,600	0·2656	0·1328

Per cent Return on Investment:

On Gross Profit Basis	54·1%

The actual selling price will be dependent upon the prevailing prices of imported powdered and condensed milk as well as upon the price of natural milk. However, it is evident that there is a wide enough profit margin to absorb a considerable price reduction.

The company formed to construct and operate the proposed plant may be either a government corporation, a joint venture operation, or a private capital enterprise.

In the United States the average yield of soya beans is about 20 to 22 bushels per acre. Recent (1949) average prices received by the farmer for this product were $2.12 per bushel (K10.00). About 12,000,000 acres are regularly planted to soya beans.

In Burma there are no records of the actual production of soy beans. It is estimated that between 1,500 and 4,500 tons per year reach the Rangoon market. The proposed plant will require 1,150 long tons per year to support its operation. Sufficient acreage of soy beans required to support the plant can be developed during the period of its construction. Current prices are:

Domestic		K530–725 per long ton
Imported:	ex country of origin not including duty.	
	ex Hongkong	K830 c.i.f./per L.T.
	ex Manchuria	K630 c.i.f./per L.T.
	ex U.S.A.	K565 f.a.s./per L.T.

The additional raw material requirements are (per year):

210 tons soya oil
277 tons dextrin-maltose (or glucose)
24 tons sugar
106 tons cane sugar
196 tons dextrose
17 tons salt
12 tons { Soda bicarbonate
Vitamin concentrates

All of these can be produced in Burma.

The plant would help both farm and national income, as its product is needed in Burma. It should be constructed as soon as possible after the first year plan has been financed. Additional plants would be justified when this milk substitute has been introduced and if public reception to it is favorable.

(12) Soap

Soap is manufactured in Burma, though a substantial part of it is substandard in quality and the production has been insufficient to meet the national demands. Most high grade laundry and toilet soaps are imported. Import figures for a number of prewar and postwar years are shown in the table below.

Year	Household and Laundry		Toilet		Total	
	Cwt.	K	Cwt.	K	Cwt.	K
1937–38	64,392	12,94,146	3,494	2,73,227	67,888	15,67,373
1938–39	70,213	13,27,072	3,097	2,60,486	73,310	15,87,558
1939–40	94,666	17,52,531	4,684	3,32,125	99,350	20,84,656
1940–41	87,156	17,01,152	4,228	3,40,985	91,384	20,42,137
Average Prewar	79,107		3,876		82,983	—
1946–47	28,485	14,90,876	1,393	1,44,652	29,878	16,35,528
1947–48	30,927	18,14,653	356	68,171	31,283	18,82,824
1948–49					49,000	40,55,000
1949–50					31,000	26,07,000
1950–51					21,000	18,31,000
1951–52					33,000	32,13,000

The postwar imports have averaged only 59% of prewar, but the percentage of each type of soap imported remains constant at 95% and 5% for household and laundry soap and toilet soap respectively. As the declared import value of imported soap per cwt. is now approximately four times that of prewar, the foreign exchange requirement to purchase soap abroad is becoming greater each year.

Good soap in substantial quantities can be made in Burma. This will be particularly true when the pulp and paper factory is in operation with its supporting caustic chemical plant. From this source will come the soda ash required by a soap plant. The other raw materials will all be available from domestic sources. Oils are obtainable from sesamum, groundnuts or soy beans. While all of these are in short supply now, other oil will be made available from rice bran and/or cotton seed. A valuable by-product of a soap plant is glycerin which can be used in the manufacture of pharmaceuticals, and eventually dynamite.

A 10,000-ton soap plant was recently put into operation in Burma by private interests. This plant will contribute materially to the reduction of soap imports since the output will be considerably above prewar imports.

(a) **Recommendation.** It is recommended that the manufacture of soap be left to private enterprise. Present facilities, including the newly-built soap factory, and cottage industry production should be able to handle Burma's soap requirements without Government participation in this industry. Until soap of higher standard quality is produced in Burma, there will probably continue to be imported a small amount of high grade laundry, toilet and medicinal soap. The Government should establish and enforce minimum quality standards for protection of consumers.

(13) Vegetable Oils

(a) **The market.** Burma, although primarily an agricultural country, is critically deficient in vegetable oils and oilseeds. In these commodities import expenditures exceed export receipts by over K5,30,00,000 per year. This represents importation of almost 30,000 tons of oil and oilseeds.

The current consumption of oilseeds and oil is lower than that of the immediate prewar years because of the reduced level of income, but there is a definite upward trend and forecasts indicate that this will be maintained. Per capita consumption is presently very much below desirable standards.

Vegetable oils are an extremely important part of the Burmese diet, especially groundnut oil. The complete fat content of the diet, except for minor amounts obtained incidentally in the consumption of meat, fish, and milk, is derived from these oils. The WHO, and others, have indicated that the diet of the average Burman is more deficient in fats than any other single item.

(b) **Domestic production of vegetable oils.** Oilseeds can be produced domestically at a lower cost than imported seeds. The agricultural section of this Report discusses proposed targets for future output and the problems likely to be encountered in the cultivation of the various oilseed crops. The increased production of oilseeds will provide some additional materials for oil extraction, although another more readily available raw material, and one hitherto unused, is rice bran. Acreage given to rice, or any other exportable crop, will earn foreign exchange. Therefore the desirability of cultivating crops especially for their oil content should be evaluated against the availability of oil from rice bran, an inevitable by-product of Burma's major crop.

The extraction of oil from a widely available raw material, with which every Burman is well acquainted, accords with the general program for economic development. The individual plants give excellent returns on the capital invested, and, as the plants will be situated in various geographical locations, the benefits derived will be spread over a wide section of the population. Expressed in terms of oil equivalent, Burma in 1951–52 used 86,000 tons of oilseeds and oil, of which imports amounted to over 28,000 tons.* Prewar consumption approximated 110,000 tons of oil equivalent, of which 17–20,000 tons were imported.

Rice bran generally contains between 14% and 22% of oil. Bran from Burma rice averages 17% of oil. This oil is at present unused. Except for a small residue, almost all this oil can be extracted. Rice bran is commercially available. Current 1952–53 estimates indicate 179,000 tons, while 1959–60 forecasts show 272,000 tons.

(c) The plant. A solvent extraction plant to process bran at the rate of 100 tons per day would produce 14·25 tons per day of marketable rice bran oil, plus a small percentage of heavier residues. On normal 200-day operation this would amount to 2,850 tons of oil per year. The oil produced by this process is edible. It is also palatable being both odorless and tasteless, and besides being an edible oil, is suitable for many industrial uses including soap and cosmetics manufacturing.

This project has been presented in more detail in a project report previously submitted to Government. The estimated cost of producing rice bran oil is K683.55 per ton, due allowance having been made for the decreased quantity and lowered sales value of bran from which oil has been extracted. By comparison, imported groundnut oil costs K1,800.00 per ton and coconut oil K1,555.00 per ton on a c.i.f. basis. Using a weighted average, a price of K1,600.00 per ton is indicated for comparative purposes, the proposed extraction plant gives an estimated annual gross profit of K26,07,000. A plant of this size is estimated to cost K35,22,250; K5,06,000 in local currency and K30,16,250 in foreign exchange. This indicates that the plant can be paid for out of profits in less than eighteen months.

(d) Availability of management and labor. The project, although a simple chemical process, will require more technicians and management than it is possible to train in the time required to implement this project. However, this deficiency can be overcome by means of a management contract with an appropriately qualified concern that could train Burmese counterparts to take over the complete operation within three to five years, or less if highly qualified persons become available.

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* 1951–52 imports: groundnut oil 8,519 tons, coconut oil 2,076 tons, valued at K4,73,61,869.

The extraction of rice bran oil will be a new industry. Burma is an oil-deficient country. Therefore, as rice bran oil is intended to replace imported oils and not to supplant domestic oils such as sesamum and groundnut, it will create employment in the extraction or processing plants. Similarly, additional employment will result from raw material procurement and finished product distribution. As the product has a high sales value, it will increase the per capita income. Being produced at a low cost, the availability of the oil will tend to stabilize the market for domestic oils and thus prevent shortages which increase prices and the cost of living.

(e) National welfare. The project will make a substantial contribution to the national welfare as it moves towards making Burma self-sufficient in this commodity. As project implementation progresses and additional plants are installed, it will also reduce imports of vegetable oils required for industrial purposes. The benefits will not be restricted to any one group or class of people, as fats are required in every diet.

The proposed project in its earning capacity and elimination of imports will be of major importance to the economy. The above phase is a national step in the rehabilitation of existing industry without undue expenditures on obsolescent plants.

(f) Export of rice bran. The bran with oil extracted has a lower export value than the bran containing oil, but on the basis of United States export prices for the two types of bran, it is estimated that the difference does not exceed 10%. This loss in the export value of bran is much more than compensated for by the foreign exchange gain resulting from reduced imports of oil.

To illustrate this point, seven tons of bran will yield one ton of oil with a value of K1,600.00. Seven tons of unextracted bran, at an export price of K290.00 per ton, will bring foreign exchange receipts of K2,030.00. If the oil is extracted, 5·81 tons of bran will remain. At an export price of K261.00 per ton the 5·81 tons will earn K1,516.00 in foreign exchange. The effect of oil extraction on foreign exchange earnings may be tabulated as follows:

(1) Export value 7 tons of unextracted bran	K2,030.00
(2) Export value 5·81 tons of extracted bran	K1,516.00
(3) Loss in foreign exchange receipts (1 – 2)	K 514.00
(4) Savings of foreign exchange expenditures on 1 ton of oil	K1,600.00
(5) Net gain in foreign exchange (4 – 3)	K1,086.00

Furthermore, there is a foreign market for only a small fraction of Burma's bran at the present time. It would therefore be possible to extract oil from a very large quantity of bran without reducing exports of bran containing oil. The gain in foreign exchange so long as this circumstance continues would be the total value of the oil extracted, or K1,600.00 per ton. Thus it can be seen that the net effect on foreign exchange will be a saving of K31,00,000 to K46,00,000 annually for each plant put into operation.

(g) Recommendations. On the basis of imported oil for edible purposes Burma could absorb the output of ten such plants. This would require a long term program. Immediate benefits would be gained by constructing one plant now, followed by two additional plants at suitable outports as soon as operating experience has been gained.

It is recommended that a solvent extraction plant for the production of rice bran be constructed in the Rangoon area in the near future; that steps be taken to procure a suitable site; and that contract be made for the engineering design of the plant at the earliest possible date. The orders for equipment and materials should be placed as soon as the construction drawings have advanced sufficiently to permit. The construction of the plant and storage facilities should be performed by contract with a firm experienced in chemical plant construction.

(14) Rice Milling

Rice is the most important product of Burma. Its production furnishes most of the agricultural employment. It is the basic food of the nation and of neighboring countries. As it is always produced in excess of national requirements its export brings to Burma the greatest portion of the foreign exchange required to pay for imported commodities.

The 1953 yield is estimated to be 5,740,000 long tons of paddy and for 1959–60 it is expected to be 7,440,000 long tons. As the domestic consumption is not expected to increase greatly in this period, except for normal increases in population, the additional rice is primarily for export to increase the foreign exchange resources of the Government. The prewar rice acreage was 12,832,000 and the average crop 7,426,000 long tons per year. As the world price has increased greatly since the war, the revenue from the export of rice greatly exceeds the prewar income, even with a smaller crop.

As rice is such an important crop to Burma the milling of rice commands a correspondingly important place among the industries of Burma. Because rice is grown in practically every district in Burma the rice mills are well dispersed in seven principal groups. The number of mills and their locations are shown in Table XXII–3 along with the number employed.

TABLE XXII – 3

District	*Rice Mills No. of Mills* 1940	1952	*No. of Workers* 1941	1952	*Capacity Tons*
Arakan Division					
Akyab	22 – 5	17	5,499	3,316	675
Kyaukpyu	2 – 2		295		
Sandoway	1 – 1		32		
Pegu Division					
Rangoon Town	36	36	7,588	5,196	2,301
Pegu	67 + 10	77	2,682		
Tharrawaddy	43 + 22	65	2,442		
Hanthawaddy	40 + 3	43	3,575	1,126	1,100
Insein	29 + 12	41	2,240		
Prome	29 – 5	24	1,170		
Irrawaddy Division					
Bassein	56 – 4	52	3,904	4,069	2,161
Henzada	36 – [illegible]	35	2,178	2,240	1,234
Myaungmya	68	68	2,090	2,170	2,008
Maubin	14 + 5	19	330	532	320
Pyapon	52 –19	33	1,936	1,612	920
Tenasserim Division					
Thaton	28 – 17	11	819	261	149
Amherst	34 + 12	46	1,899	1,372	1,118
Tavoy	7 + 3	10	236	205	269
Mergui	3 – 3		97		
Toungoo	22 + 5	27	848	1,065	1,085
Magwe Division					
Thayetmyo	1 – 1		32		
Minbu	18 –13	5	379	107	66
Magwe	—		—		
Pakokku	—		—		
Mandalay Division					
Mandalay	13 + 1	14	298	340	240
Kyaukse	7 + 5	12	160	237	234
Meiktila	—		—		
Myingyan	—		—		
Yamethin	9 + 3	12	169	265	161
Sagaing Division					
Myitkyina	7	7	187	143	94
Shwebo	17 + 12	29	319	556	384
Sagaing	—				
Katha	7 – 3	4	146	86	52
U. Chindwin	—				
L. Chindwin	5	5	76	84	30
Total	673 19	692	41,626	24,982	14,601

The existing milling capacity is well in excess of present production, and is in excess of any projected production in the foreseeable future. There is therefore no present need for new capacity as such. The principal interest now is in improving the process and in modernizing the existing mills to reduce milling costs and to improve the quality of the finished product.

The quality of the finished product is partially dependent upon the quality of the paddy grown. It has been reported that the milling of rice in Burma produces a greater per cent of broken rice than in any other rice milling country. This per cent of broken rice is much greater than in prewar years. The deterioration results from the fact that not all mills are in as good condition as before the war, and from a considerable reduction in the quality of the paddy.

An investigation of rice and the rice milling industry was made for the State Agricultural Marketing Board in November 1951 by ECA. This report stated that the present poor quality (variable grain sizes in the same varieties of rice) was caused by the interruption during the war, of an active program to improve quality and yields of all standard varieties and to improve grains for the European markets. The uneven grain sizes, unless carefully separated at the rice mill result in large breakage losses. The broken grain brings a lower export price and thus causes a large revenue loss to the Government. In addition, the export market for substandard rice is limited. The poor quality has already resulted in the loss of some of the large European markets to other countries offering superior grains.

The report stated that almost all of the mills should improve paddy storage and handling methods which result in serious losses and are too costly. It further stated that about 50% of the mills visited were found to be impractical to modernize, in that only a few machines, if any, could be used in modernization plans. On the other hand, it was interesting to note that about 50% of the mills could be modernized with a small investment and with very little installation time required. Generally, the mills were found to be either in a state of disrepair which precluded modernization, or in very good condition so that little extra equipment besides the rough rice classification machines is required to bring them into top condition. By classifying the rice initially and by other modifications the breakage can be held below 5%.

The production and recovery of by-products needs improvement. The report recommended the purchase and construction of a small modern American rice mill to demonstrate modern means of decreasing breakage. This mill is expected to be in operation in the near future.

The following definite recommendations were made to modernize the Burma mills:

(*a*) Paddy rice cleaners—usually only perforated oscillating screens—should be replaced by the S. Howe's "Eureka" cleaner, or equivalent, which does a more accurate job and salvages more by-products.

(*b*) Chaff separators—usually a huge machine composed of many fans which loses all the by-products—should be replaced by S. Howe's "Eureka" Chaff Separator, or equivalent, for reasons given in (*a*).

(*c*) Rough rice classification equipment should be added to decrease breakage; the reasons being outlined in discussion on "Modern Rice Milling."

(*d*) All under-runner shellers (called hullers in Far East) whose casings are of sheetmetal construction should be replaced by shellers using heavy gray iron castings. The Engelberg Huller Co.'s under-runner shellers are recommended for their quality of workmanship, large capacity, and adaptability for modernization plans (no extended shafts are used as with the older European machines).

(*e*) English type gyrating screen machines should be replaced by the more efficient standard paddy separators made in Germany, England, and the United States.

(*f*) Stone cones with no material handling equipment for bran should be replaced with those that have such material handling facilities. Before replacement of these machines, tests should be completed on the new American rice mill which has Engelberg Hullers and is believed by American millers to be more efficient and less troublesome than the cones.

(*g*) Perforated screening equipment or slow speed indented drum separators should be replaced using the modern disc separators (Hart-Carter Co.) or the high speed indented cylinder separators (Superior Separator Co.).

(*h*) Most of the wooden elevators in mills to be modernized will have to be replaced; this should be done using steel or cast iron heads and boots and native lumber trunkings or all steel elevators including steel trunking.

(*i*) Wooden aspirators should be replaced by more modern and efficient machines such as manufactured by the Hart-Carter Co. or the Superior Separator Co.

The ECA report covers the present situation. Its recommendations must be carried out if Burma is to sell rice in the export market in competition with countries offering superior rice.

One important process should be added to the rice milling process, that of rice enrichment. In producing white polished rice most of the valuable vitamins are retained in the bran. These vitamins may be replaced easily by treating one part in 200 and mixing the treated grains with the untreated grains. The process costs little and is an effective and simple way of enriching the diet of the people. Such enrichment programs are in effect in the Phillipines, in Puerto Rico and in Thailand. It has been started in Singapore. A plant to treat 120,000 pounds in six hours would cost only Malay $25,200. The treating cost, exclusive of the rice cost, is about M $1,044 per ton of treated rice which is ample for 120,000 pounds of mixed rice. The steps recommended are the following:

(*a*) Organize an intensive short and long range program to improve and standardize rice growing.

(*b*) Continue to offer a premium for less breakage to encourage the millers to modernize their mills along the lines recommended.

(*c*) After the pilot rice mill has established the best system of rice milling, the Burma mills should be modernized to incorporate the improvements found to be desirable, so that all mills will be raised to the same standard of efficiency.

(*d*) Gradually replace the obsolete mills by new and efficient modern mills.

A complete project report on rice milling, including costs, has been prepared and will be submitted.

(15) Flour Milling

The *Burma Labor Gazette*, September 1951, lists 80 flour mills in Burma. Burma produces wheat, rice, corn and soy beans from which flour and meal may be made. There are no important imports of flour. The diet of the Burmese does not include much food in the preparation of which flour is used. It may be presumed that the existing flour milling industry can supply all domestic demands. Therefore no new mills are recommended for the near future. The development of flour milling to meet the requirements of the nation during the foreseeable future can be met by private enterprise without the participation of Government.

(16) Starch

Starch is a standard food and household product that may be manufactured from either corn (maize) or rice, but preferably from corn, as the yield of starch is much greater. Both grains are normally grown in Burma in quantities great enough to support the operation of a moderate sized corn starch plant. The products can be consumed nationally, or be sold in export.

A single corn starch plant exists in the Rangoon area. When inspected, this plant had been idle for a long period. It was reported that not enough corn had been available since the war to support its operation and that permits to use rice had not been granted. An existing industry of this type should be encouraged to resume operations to provide both a standard food and employment. No new plants are required at this time.

(17) Sugar and Sugar Chemicals

(a) The market. (1) In a country where soil and climatic conditions are favorable for sugar cane growing, it is paradoxical that Burma has in the past imported and at present continues to import white sugar to supplement domestic production.

There have been two commercial sized white sugar factories in the country supplied by domestic cane. One of these, at Sahmaw, was so badly damaged during the war that it has not since been rehabilitated. An existing factory, at Zeyawaddy, is in operation with an annual capacity of about 15,000 tons of white sugar.

Prewar consumption of white sugar averaged about 40,000 tons. Sugar imports in recent years were:

Year	*Tons*	*Value (Kyats)*
1947–48	3,356	21,80,263
1948–49	5,034	37,36,853
1950–51	6,527	60,57,644
1951–52	11,550	1,14,85,657

These figures show a rising consumption in excess of existing production which is indicative of a need for additional domestic production.

The 1953 first quarter average retail price for white sugar in Rangoon was K2.42 per viss (K0·673 per pound). In other localities the price reached a top of K3.00 per viss. Considering the quality, the market price is fairly high.

Sugar produced locally and imported into Burma is of substandard grades; the crystals are large and sometimes covered with syrup and, as sold, usually contain impurities and contaminants. Actually, there is not, and has not been in Burma, a sugar refinery as that term is accepted throughout the world. White sugar produced domestically is the type known in the Cuban, Phillipine and Hawaiian sugar trades as "plantation whites" and "Turbinado" sugar, a semi-refined co-product of raw sugar mills or "centrals." A perennial housewife's complaint in Rangoon is the poor quality of available sugar.

Conventional refining practice in Europe, United Kingdom, America and other countries starts with "raw" sugar. This material is produced in mills (centrals) located in or close to growing fields. After harvesting, cane is crushed and processed in these mills to a brown, crystalline sugar which contains molasses, syrup, mineral and other impurities. This sugar is imported into non-cane growing or cane deficient countries where it is refined to high purity by processes that use animal bone or vegetable char as filter, decolorant and decontamination agent.

(2) The "refined" sugar industry in the country at present is small scale in volume and seasonal in activity. The factories operate only during the harvesting season, a procedure that adds to capital cost.

The sugar refining industry proposed herein is based on the modern system of relatively small mills located in or adjacent to adequate growing areas crushing and processing cane to raw sugar during the harvest season. The sugar is then shipped to a refinery that operates on a year round basis (300 days). This system, which is conventional practice in western countries, permits low ratio of investment to output of the refinery, location of refinery close to finished sugar market center and dispersion of raw sugar mills in growing areas. Further, location of the refinery at a port, such as Rangoon, would permit importation of raw sugar and, conversely, export of raw or refined sugar.

(3) Since there are no refineries in southeast Asia, including Indonesia, an export market for high grade sugar in the area may be developed. Transportation costs on both raw and refined sugar would place European competitors at a disadvantage.

(b) Possibility of domestic production. (1) The industry proposed consists of a 30,000-ton refinery working 300 days per year and supplied with raw sugar from mills or "centrals" located within an economical transportation radius of growing areas. The capacity of the raw sugar mills would depend upon the productivity of an area; optimum capacity will probably be 10 to 12,000 tons of raw sugar per season of 100 to 120 days in which case three would be required to supply the refinery. The "centrals" will cost about 70% of the investment in the refinery or about £460,000. Total investment in refinery and centrals is estimated to be K1,16,04,000.

(2) An important aspect of the project, aside from the ready salability of its principle product, is the use of by-product molasses for the manufacture of alcohol. Molasses from refinery and raw sugar mills can be used for the purpose. Approximately 105,000 gallons annually will be available, enough to make 41,000 gallons of alcohol. Utilization of by-products is covered in a separate project report which will be submitted in the near future.

(3) The paramount criterion of the project is economy. Can a high quality product be produced at a cost that will find wide acceptance? Mill cost of packaged refined sugar is estimated at K1.23 per viss. Production costs of the usual substandard white sugar available in the market are not known but the retail price (first quarter 1953) in Rangoon of K2.42 per viss is indicative of a spread that would make the

high grade sugar competitive. Most certainly the retail price of the quality product would be no higher.

(4) It is estimated that approximately 70,000 acres suitable for cane cultivation are dispersed among the Myitkyina, Kyaukse, Yamethin, Pegu and Toungoo areas. On the basis of average yields, a potential 84,000 tons of raw sugar annually exists.

Actual cane production figures in past years have been:

Period	*Prewar*	*1938-39*	*46-47*	*47-48*	*48-49*	*49-50*	*50-51*	*51-52*	*52-53*
Tons (1,000)	840	780	534	515	534	450	455	540	575
Per cent of pre-war	100	93	64	61	63	54	54	64	69

Since the proposed refinery capacity is only 30,000 tons annually, on the basis of an 8% refined sugar yield, only 375,000 tons of cane are required, a volume well below present production figures. Of course, all cane produced would not find its way into refinery channels, jaggery and other products would continue to be produced.

(5) Other input materials will be imported until they are available locally. The annual requirements of these materials are:

Dry phosphoric acid	27 tons
Make-up bone char	10 tons
Coal	3,600 tons
Fuel oil (for char kiln)	425 tons

All of the above materials are available from several sources in the sterling area. Repair and maintenance supplies will be available from equipment manufacturers who supply the original installation.

(6) Direct production labor requirements are 20 men, three foremen, and one superintendent per shift or 72 men. In addition, maintenance, office and management staff will require about 30. A common labor force, handlers, cleaners and watchmen, of about 20 will be required, bringing the total personnel to about 122.

This project, by its character, should appeal to the local investor or businessman as it opens possibilities of a joint venture wholly owned within the country. Only a few foreign technicians (possibly six) will be required for the first few years of operation. Since the refinery proposed is for the production of a single grade of refined sugar, manufacturing routines are not complicated. There are several phases, however, that require considerable skill which is attained through experience. The employees will have to apply themselves assiduously to absorb the skill of the imported technician-instructors.

(c) Economic feasibility.

(1) *Description and cost of refinery*

The refinery proposed is for the production of 200,000 pounds of refined, granulated sugar per 24-hour day by the bone char process from 96° commercial raw sugar. The process is described below.

(*a*) *Cutting-in station.* Raw sugar shipped in gunny bags or in bulk is stocked in godowns. From the godown, bags are conveyed to the cutting-in station, and manually opened. After opening, the sugar is conveyed to a 60 short ton storage bin, a capacity which enables transfer from godown during daylight hours only. Raw sugar then passes through a sugar lump breaker, is elevated to the sugar mingler, mixed with hot saturated syrup, heated and mingled. From the mingler, the magma passes through Maisching rolls to insure that all lumps in the magma are crushed.

(*b*) *Affination centrifugal.* The magma is discharged from the Maisching rolls by gravity to the mixer of the affination centrifugal, where it is washed to a purity of not less than 98·5° Brix. The washed sugar is delivered by a scroll conveyor under the centrifugal to the sugar melter. Syrup runoff from the affination centrifugal is pumped to the vacuum pan supply tanks to be reboiled to produce raw sugar.

(*c*) *Sugar melter.* Liquor from the sugar melter is diluted to a density of about 58° Brix, heated to a temperature not exceeding 160° F. and delivered to the liquor screen. This screen eliminates all non-soluble foreign matter such as lint, straw, canvas or thread from the raw sugar bags or unmelted sugar lumps or gums. The screened liquor passes to the liquor treatment tanks and the trash is discharged to the filter press and tank.

(*d*) *Liquor treatment tanks.* The screened liquor is treated with milk of lime and phosphoric acid in the liquor treatment tanks and is pumped to the elevated feed tank above the clarifier.

(*e*) *Flotation type clarifier.* Liquor from the high level feed tank passes through an emulsifier and through liquor distribution pipes to the clarifier. Rising air bubbles, aided by the increased temperature of about 180° F. carry the impurities to the surface, where a blanket of scum is formed, the clear liquor remaining beneath the surface. This method of clarification eliminates a substantial portion of coloring matter, and reduces materially the quantity of bone charcoal subsequently required. The blanket of scum is continually removed to the scums gutter, clear liquor runoff is carried by overflow liquor pipes, the flow being regulated by adjustable level controls. Low pressure steam coils are provided in the clarifier to maintain desired temperature. Clear liquor from the clarifier is pumped to the char filters. The scums are discharged to the scum diluting tank, which is provided with blow-up coils, and diluted to 15° Brix, then pumped to subsiders. The clear liquor runoff goes to the affination melter and the bottoms to the filter press mud tank.

(*f*) *Filter press.* Bottoms from the scums subsiders are blown up in the filter press mud tank, heated to 200° F. and pumped to the plate and frame filter press. Clear liquor returns to the sugar melter. Mud from the filter press is discharged to a mud hopper and thence to discard. Filter cake is sweetened with hot water before discharging. Filter cloths are washed in cloth washing tank.

(*g*) *Char handling equipment.* Bone charcoal is used to eliminate the remaining coloring matter and most of the residual soluble impurities in the clarified sugar liquor.

The char is re-used in a continual cycle, passing in rotation through the char filters and the char revivifying kiln by means of char handling equipment. Char dust is eliminated by a char screen. The average life of the char is about five years of continuous service before replacement is necessary. The liquor from the clarifier is kept at a temperature of 180° F. by the liquor heater, and passes through the char filter. Filtered liquor from a freshly charged filter emerges almost water white, and the char filter may be used from 18 to 24 hours before traces of color again appear at the liquor runoff station. The liquor is then switched to a freshly charged filter, and the used filter washed with hot water, blown down with air pressure and the char discharged by gravity to the wet char chute and by char elevator to the wet char bin over the char dryer.

Dry char from the kiln is continuously discharged and elevated to the standby char filter as required.

(*h*) *Evaporator station.* In order to increase the fuel economy of the refinery a supplementary multiple effect evaporator is recommended to raise the density of the sweet wash water from the char filters and to concentrate the white liquors from 58° to 70° Brix or more as desired.

(*i*) *Boiling house.* Vacuum pans handling the refined sugar massecuites are intended to operate on a four-boiling-per-shift schedule. A separate installation of syrup supply tanks, vacuum pans, mixer, centrifugals, sugar conveyors and syrup blow-up tanks is provided for the refined sugar only. Remelts and low grade syrups are handled by a separate installation of tanks, vacuum pan, crystallizers, mixer, centrifugals and blow-up tanks. The raw sugar produced is washed in the centrifugal basket and is returned to the affination melter. Molasses is returned to the vacuum pan supply tanks for low grades, and the final molasses is discharged to the molasses scale for by-product conversion.

(*j*) *Refined sugar handling.* Moist sugar from the refined sugar centrifugal is handled by one conveyor, elevator, sugar bin and granulator. The massecuites from the vacuum pans are discharged to the centrifugal mixer in the pre-determined schedule of purities and each "strike" of sugar is segregated by the operator at the dry sugar storage bin which is divided into compartments for 1st, 2nd and 3rd, and 4th sugars. Separate discharge spouts are provided and adjusted to give a blended grade of commercial refined sugar to the bagging scales.

(2) *Capital cost*

The estimated capital cost is:

(*a*) *Machinery and equipment*

Cutting-in Station
Affination Station
Clarification Equipment
Char House Equipment
Boiling House Equipment
Sugar Handling (Bins and Conveyors)
Boiler House Equipment
Power Plant Equipment (300 kW generator)
Pumps
Tanks
Piping
Sheet Metal Work
Instruments
Packaging Equipment
Heating Insulating Material
Electric Wiring, Steam and Water Piping
Initial and one year make-up of House Char (400,000 lbs.)
One Year Supply Phosphoric acid (60,000 lbs.)

Total Machinery and Equipment f.a.s. K31,00,000

(*b*) *Buildings*

Affination House	
Clarification House	
Char Kiln and Filter House	
Boiling House	
Sugar Room	
Boiler and Power House	
Structural Steel Framing for above	K 6,04,000
Ocean Freight and Insurance for equipment and Structural Steel	3,08,000
Other building materials Brick, Cement, Re-in-forcing Steel and Construction Labor for entire Refinery	10,22,000

Raw and Refined Sugar godowns including material and construction	2,00,000	
Total Building Cost	K21,34,000	
Land and Site Preparation Railroad siding and Roads	5,00,000	
Contingencies	5,00,000	
Engineering and Drafting	6,00,000	
	16,00,000	
Total Capital Cost		K68,34,000

Of the total cost approximately 70% or K47,83,000 will be required in foreign exchange.

(3) *Production cost*

The estimated production cost on a per ton (2,000 lb.) basis is:

(*a*) *Materials*		
Raw Sugar	K417.00	
Make-up Char, Phosphoric Acid, Lime, and Fuel (this item includes Power, Steam and Water)	212.00	
Labor	29.30	
	K658.30	K658.30
(*b*) *Fixed Charges*		
Equipment and Buildings—20-year life foreign exchange purchase K47,93,000 at 8·024%=K3,83,000	12.80	
Equipment and Buildings—20-year life domestic currency purchase K20,51,000 at 7·36%=K1,51,000	5.03	
Insurance and Taxes at 1% of K68,34,000=K68,340	2.05	
	K 19.88	K 19.88
Total Production Cost per ton		K678.18
Total Production Cost per viss		K 1.23

Transportation, distribution cost and retails profit must be added to mill cost to ascertain retail price. The average retail price of sugar in Rangoon shops for the first quarter of 1953, as an example, was K2.42 per viss. The spread between mill cost and market price then is K1.19 per viss, an amount estimated to amply provide for transportation, distribution and profit.

Packaging in individual 1 or ½ viss paperboard cartons would add about 10% to mill cost but would add to the attractiveness of the product. This merchandising feature should be considered when finalizing the project.

(d) Recommendations. The spread between estimated mill cost and retail prices is evidence that sugar cane growing has exceeded existing mill capacity and is justification for initiation of the subject project. Implementation will add to the food supply, will introduce a high grade product in the economy that will sell for the same or a very little more than the present substandard product, and will provide incentive for cultivators to increase their crops.

It is recommended that designs and firm proposals be obtained for both refinery and raw sugar mills and investigation be carried further to determine optimum location of elements of the entire scheme.

(1) *Implementation schedule*

Equipment deliveries vary according to country of manufacture. A United States firm quotes initial delivery in eight and completion in about eighteen months. If comparable deliveries obtain generally, the factories could go into production in about 2½ years by following the suggested schedules:

(*a*) Fiscal year 1953–54	
Site Surveys and Purchases	K 5,00,000
Engineering and Design	K 3,00,000
Payment with order on principal equipment and building material	K30,00,000
(*b*) Fiscal year 1954–55	
Engineering and Design balance	K 3,00,000
Balance of payments on equipment and material	K10,00,000
Payments on construction cost	K15,00,000
(*c*) Fiscal year 1955–56	
Final payments on construction	K 2,34,000

Construction schedule will closely parallel expenditures.

(18) Bagasse Pulp and Paper

Attention has for some years been given to the use of bagasse (sugar cane stalks after the juice has been extracted) for pulp and paper making. Use of the material is motivated by two reasons; to reduce the cost of sugar through by-product utilization, and to supplement cellulose materials in those countries where the consumption of pulping woods is outstripping new growth. Since more efficient sugar refinery design and operation has reduced fuel consumption, for which bagasse is used, the large excess of the material has further spurred research in its use as paper-making material.

Commercial mills now in operation use bagasse pulp with admixtures of other pulps for heavy papers for containers. There have been recent reports of a patented process for making newsprint, but it is too early to seriously consider such an operation for Burma.

While emphasis should be placed on carrying out the bamboo pulp and paper operation, the possibilities of bagasse should be explored in the future as another element in the pulp and paper products industry with particular reference to boxboards, heavy papers and wall boards of the Cellotex type.

Increase in sugar production may open possibilities of obtaining a cheap pulping material if the mill is located in the vicinity of a raw sugar mill to save transportation.

(19) Timber and Timber Products

(a) Sawmills

This section dealing with the processing of raw logs assumes a "normal" flow of new teak log supplies to mills of from 400,000 to 500,000 cubic tons annually. The present flow is equivalent to about 80,000 tons. It is obvious therefore that the implementation of some of the recommendations pertaining to sawmilling and in particular to the erection of a new sawmill capable of converting 130,000 cubic tons of logs annually, may not be of immediate urgency. Of much greater urgency is action with respect to the assurance of a continuance of an increased flow of teak logs from the forests to mills, as pointed out in Chapter XXIV. In the meantime, the plans for additional milling capacity to supplement existing operative and idle capacity and the mill that is in the process of erection should be prepared. Actual erection should be timed to coincide with the hoped for increase in new supplies.

(1) *Existing plants*

A survey of the location and capacity of all the sawmills in Burma was made to determine the country's present capacity for the production of lumber. A condensed summary of the survey is given in Table XXII-4.

It was reported that during 1951–52 these sawmills produced 243,405 cubic tons of converted lumber, approximately 50% of the reported capacities of the sawmills. The three most important sawmilling districts are:

Moulmein	28 mills	72,750 c.t. round logs
Mandalay	18 mills	106,550 c.t. round logs
Rangoon	51 mills	372,055 c.t. round logs
	97 mills	551,355 c.t. round logs

These mills produced at about 55% of their rated capacities in 1951–52. These districts, with 28·8% of the sawmills of Burma, are capable of sawing 58% of the lumber produced in the country.

TABLE XXII – 4

ANNUAL PRODUCTION CAPACITIES OF SAWMILLS IN BURMA

Circle	Number of Mills	Principal Locations	Production Capacity Round Logs Tons per yr.
Maritime	79	Bassein, Nyaunglebin, Moulmein, Akyab	111,357
Sittang	36	Pyinmana, Toungoo, Pyawbwe, Pegu	91,581
Northern	71	Mandalay, Katha, Shwebo, Myitkyina	200,256
Chindwin	32	Monywa, Meiktila, Kyaukse, Thazi	103,320
Utilization	51	Rangoon Area	372,055
Hlaing	41	Hlegu, Minhla, Nattalin, Paungde	53,837
Shan States	26	Namtu, Mamahkaw, Lashio, Loikaw	17,220
Totals	336		949,626

(2) *The market*

(*a*) *Exports.* Export data show the postwar sales abroad for teak and other hardwoods have dropped materially below those of prewar. These data in terms of cubic tons of converted timber are as follows:

Teak		
1937–41	average,	213,000 cubic tons
1946–52	average,	55,000 cubic tons
1947–48	high year,	91,000 cubic tons
1949–50	low year	16,000 cubic tons
1953	estimate,	80,000 cubic tons
Hardwoods		
1937–41	average,	41,000 cubic tons
1946–51	average,	15,000 cubic tons
1947–48	high year,	32,000 cubic tons

With the return of security in the forest areas it is safe to assume that export of teak and hardwoods may be brought up to 200,000 and 40,000 cubic tons of converted timber respectively each year. The milling of teak and other hardwoods for export would require about 40% of the capacity of the existing mills if all exports were in the form of converted timber.

(*b*) *Domestic demand.* Estimates were made of the probable growth of demand for timber and lumber products in Burma giving consideration to the requirements of the housing and economic development program from 1952–53 through 1959–60. A summary of these estimates in cubic tons of round logs and of finished lumber is given in Tables XXII–5 and XXII–6 (*see next page*).

The domestic lumber requirements for 1952–53 are estimated to be 507,250 and for 1959–60 995,500

TABLE XXII – 5

ESTIMATED LUMBER REQUIREMENTS 1952–53

Use	*Teak Cubic Tons*		*Durables* Cubic Tons*		*Semi-Durables* Cubic Tons*			*Non-Durables* Cubic Tons*	
	Round Logs	*Finished Lumber*	*Round Logs*	*Finished Lumber*	*Round Logs*	*Finished Lumber*	*For use as Round Logs*	*Round Logs*	*Finished Lumber*
Housing	16,000	8,000	24,000	13,400	283,000	184,000	—	3,000	2,000
Plywood	—	—	—	—	—	—	—	—	—
Furniture, etc.	8,000	4,000	834	500	—	—	—	—	—
Engineering Construction	2,000	1,000	13,333	8,000	15,385	10,000	—	3,750	3,000
Transportation	16,000	8,000	33,333	20,000	30,765	20,000	—	12,500	10,000
Telephone, Telegraph and Electric Communication	—	—	—	—	—	—	4,000	—	—
Industry	1,000	500	5,000	3,000	12,300	8,000	5,000	12,500	10,000
Agriculture and Piscatorial	—	—	1,666	1,000	3,010	2,000	—	5,000	4,000
Miscellaneous	—	—	834	500	1,540	1,000	—	2,500	2,000
Exports	160,000	80,000	50,000	30,000	—	—	—	—	—
Totals	203,000	101,500	129,000	76,400	346,000	225,000	9,000	39,250	31,000

* Note: These three headings are classifications that were established by the Forest Department in 1948 and are as follows:
Durables (Pyinkado, Padauk, Thitya–Ingyin).
Semi-durables (Pyinma-In-Kanyin and 50% of others).
Non-durables (General utility woods).

TABLE XXII – 6

ESTIMATED LUMBER REQUIREMENTS 1959–60

Use	*Teak Cubic Tons*		*Durables* Cubic Tons*		*Semi-Durables* Cubic Tons*			*Non-Durables* Cubic Tons*	
	Round Logs	*Finished Lumber*	*Round Logs*	*Finished Lumber*	*Round Logs*	*Finished Lumber*	*For use as Round Logs*	*Round Logs*	*Finished Lumber*
Housing	54,000	27,000	96,666	58,000	646,155	420,000	—	12,500	10,000
Plywood	—	—	—	—	—	—	12,000	—	
Furniture, etc.	16,000	8,000	1,667	1,000	—	—	—	—	
Engineering Construction	2,000	1,000	16,667	10,000	15,385	10,000	—	6,250	5,000
Transportation	6,000	3,000	33,334	20,000	30,769	20,000	—	12,500	10,000
Telephone, Telegraph and Electric Communication	—	—	—	—	—	—	6,000	—	
Industry	2,000	1,000	6,666	4,000	12,308	8,000	2,000	10,000	8,000
Agriculture and Piscatorial	—	—	3,333	2,000	3,077	2,000	—	2,500	2,000
Miscellaneous	—	—	1,667	1,000	1,539	1,000	—	2,500	2,000
Exports	400,000	200,000	66,667	40,000	—	—	—	—	
Totals	480,000	240,000	226,667	136,000	709,233	461,000	20,000	46,250	37,000

* Note: These three headings are classifications that were established by the Forest Department in 1948 and are as follows:
Durables (Pyinkado, Padauk, Thitya–Ingyin).
Semi-durables (Pyinma-In-Kanyin and 50% of others).
Non-durables (General utility woods).

cubic tons of round logs. Since the total capacity of existing sawmills in Burma is approximately 950,000 cubic tons of round logs annually it is evident that serious consideration must be given to increasing this milling capacity in the near future in order to produce the export and domestic demand for lumber.

(3) *Increasing production*

There are several ways by which the increase in lumber production may be accomplished:

(*a*) By the improvement and modernization of existing mills, both government and privately owned.

(*b*) By opening the way for privately owned mills that are now lying idle to resume operations and to improve their plants.

(*c*) By constructing a new modern mill of capacity adequate to meet the nation's requirements after implementation of (*a*) and (*b*) above has been accomplished.

(*d*) Inspection of sawmills representing about 65% of production capacity of the country was made. It was found that in many of the mills the equipment was arranged in the form of a "U," presumably to limit the length of the mill, and save line shafting. This arrangement entails considerable manual shifting and turning the lumber as it proceeds from the head saw through the resaws and cutoff saws to the finishing operation or yard. The capacity of these mills can be increased by the re-arrangement of the equipment to provide for straight-line operation from the log decks through the saws. This arrangement will permit the mills to increase output by limiting the equipment time now lost while manual shifting of slabs and lumber is underway.

The capacities may be increased in the larger mills by the introduction of live rolls and power-operated conveyors. Where the mills are operated with electric energy the installation of individual motors on each unit of equipment will save power, increase efficiency and provide safer working conditions. The Government should encourage and aid sawmill owners in making improvements to mills to increase their production.

(*e*) Improvements can be made to the two European-owned sawmills in Rangoon so that their present rated capacities can be doubled. Increased production can be accomplished by the addition of another head saw (space has been provided) and other improvements. The addition of overhead cranes and live rolls would break an existing "bottle-neck" in the re-sawing operations.

(*f*) The remaining 334 sawmills of Burma can be made more productive by an estimated average of 15% which within three years would increase the capacity about 150,000 cubic tons of round logs.

(*g*) The State Timber Board is in the process of constructing a new sawmill at Singan Yard, Ahlone, with a rated capacity of approximately 50,000 to 60,000 cubic tons of round logs annually. Completion of this mill is scheduled for June 1954.

(*h*) The estimated sawmilling capacity available to meet the country's needs after the general improvements suggested above are:

Existing Mills	950,000 c.t.
Two European Owned Mills (increase)	120,000 c.t.
Other Existing Mills (increase)	150,000 c.t.
New STB Sawmill No. 3	50,000 c.t.
Total	1,270,000 c.t.

To meet the estimated lumber milling requirements for 1959–60 of approximately 1,400,000 cubic tons of round longs, additional capacity of 130,000 cubic tons should be planned. A single mill is recommended to be operated as the central plant of an integrated forest products industry. The general requirements of such a plant and estimates of capital and operating costs follow:

(4) *The plant*

The plant should be constructed in the Rangoon area where power, transportation, markets, and the advantages of integration with other allied industries may be realized. An integrated development of industries based on forest products would result in substantial savings in construction and operation costs. The plant should be on the same site with other projects for milling forest products recommended herein in order to facilitate the interchange of products between plants.

The site of the proposed State Timber Board Sawmill No. 3 (now under construction) is on property leased from the Port Commissioners, and should be reserved for future port development for the shipment of rice. The integrated lumber industries should be located further north in the Kemmendine area where there is suitable and sufficient land available to accommodate a completely integrated forest products industry development. The area surrounding the present State Timber Board Sawmill No. 1 should be acquired, thus making this mill a part of the integrated development. The site should be approximately 35 acres in area to accommodate all of the proposed wood industries. In the over-all development, State Timber Board Sawmill No. 3 and the proposed additional sawmill recommended herein could be coordinated in operations, with one plant specializing in milling teak and the other in milling non-teak hardwoods.

This sawmill will require approximately 900 boiler horsepower of steam per hour, and will occupy an area of about four acres. The main building will require approximately 15,000 square feet. The storage space and covered areas will require about 5,300 square feet, while the office will need 1,800 square feet of building. The main building would be of light steel frame with corrugated asbestos roof and siding, while the other building could be of frame with siding. It is assumed that the choice of site will be such that no foundation piles will be required, if possible. The complete development should be located along the river and be accessible to both railroad and highway transportation. For location and plant layout see Plates No. 6 and No. 7.

The estimated costs of the sawmill are as follows:

COST ESTIMATE FOR NEW SAWMILL

Cost of sawmill equipment, delivered Rangoon	K28,65,060
Transportation and insurance, from US.	2,28,140
Erection of equipment	2,88,800
Steam plant and electrical installation	3,80,000
Miscellaneous items (not enumerated)	1,42,500
Buildings	6,10,000
Concrete equipment foundations	85,500
Total cost of plant	K46,00,000
Land costs and site improvements	2,30,000
Total	K48,30,000

Equipment costs for this sawmill are based on specific quotations for every equipment item of modern sawmill equipment. The expenditures required for this plant will be approximately K31,00,000 for equipment to be purchased with dollar exchange and about K4,00,000 for equipment that can be purchased with sterling. The balance of K11,00,000 will be local currency.

(5) *Production costs.*

In estimating production costs, many variables were considered, and average weighted prices used to arrive at such cost data. Manpower requirements for the proposed sawmill were calculated from actual personnel needs of a local mill (see Table XXII–7).

Assuming an arbitrary mixed production and present-day market prices of these woods, Table XXII–8 presents a computation of the gross annual profits that may be expected.

(6) *Raw materials*

(*a*) *Requirements.* The raw material requirements for this sawmill are estimated at approximately 130,000 cubic tons of round logs annually. The mill will be capable of converting any of many species of woods of Burma.

TABLE XXII – 7
ESTIMATED ANNUAL MILL OPERATION COSTS

	K	K
Interest and Amortization (20 yrs. at ·07358)		3,39,000
Electric Power Costs at ·20 ps./kWh.		4,20,000
Steam Costs		2,85,000
Operating Personnel		
Supervisory	3,48,000	
Operations	11,94,000	
General Office	1,63,200	
Stock and Shipping	1,90,800	
Miscellaneous	4,32,600	23,28,600
Stores		6,50,000
Maintenance and Repairs		6,50,000
General Office Expense		2,27,500
Miscellaneous Expense		1,30,000
Total		50,30,100

(*b*) *Present costs of raw materials.* Present prices of teak logs delivered in Rangoon vary widely, according to the quality of the logs (which are variously designated from four-star, the best, to one-star). Current prices range from K240.00 to K340.00 per cubic ton, with an average price of about K280.00 per cubic ton. The non-teak hardwoods delivered in Rangoon average: durables, K220.00; semi-durables, K180.00; non-durables, K110.00 per cubic ton, all on a round log basis.

(7) *Personnel requirements*

In general, experienced sawmill operating labor, skilled and unskilled, is available in Burma. There appears to be a considerable difference in the use of labor and efficiency of the mill as is indicated in the comparison on the next page between a privately owned plant of 60,000 cubic tons of round logs annually and the State Timber Board Mill No. 2, which is rated at 18,000 cubic tons annually.

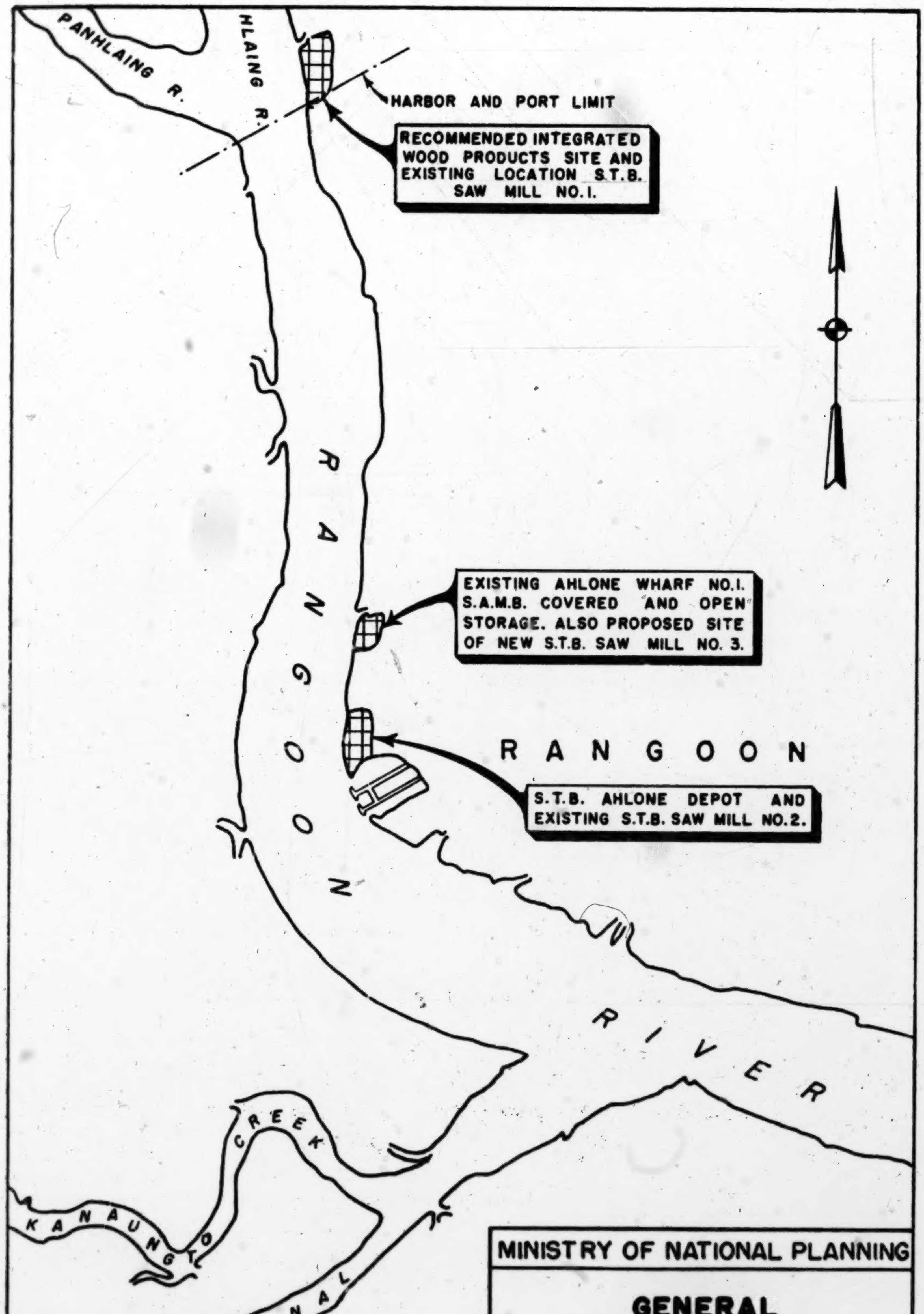
TABLE XXII – 8
ESTIMATE OF GROSS ANNUAL PROFIT

Conversion of Round Logs into Lumber

	Input		*Output*
20% Teak	26,000 c.t. rd. logs × 50%	conversion	13,000 c.t.
40% Durable Hardwoods	52,000 c.t. rd. logs × 60%		31,200 c.t.
30% Semi-durables	39,000 c.t. rd. logs × 65%		25,350 c.t.
10% Non-durables	13,000 c.t. rd. logs × 80%		10,400 c.t.
Round Logs Total	130,000 c.t.	Converted Lumber Total	79,950 c.t.

Total Operational costs K50,30,100 — 79,950 c.t. = K63.00/c.t.

	Converted Lumber Value	K
Teak	13,000 c.t. at K750	97,50,000
Durable Hardwoods	31,200 c.t. at K475	1,48,20,000
Semi-durable	25,350 c.t. at K400	1,01,40,000
Non-durable	10,400 c.t. at K200	20,80,000
Total converted	79,950 c.t. Value	K3,67,90,000


PANHLAING R.
HLAING R.
HARBOR AND PORT LIMIT
RECOMMENDED INTEGRATED WOOD PRODUCTS SITE AND EXISTING LOCATION S.T.B. SAW MILL NO. 1.
EXISTING AHLONE WHARF NO. 1. S.A.M.B. COVERED AND OPEN STORAGE. ALSO PROPOSED SITE OF NEW S.T.B. SAW MILL NO. 3.
RANGOON
S.T.B. AHLONE DEPOT AND EXISTING S.T.B. SAW MILL NO. 2.
RANGOON RIVER
KANAUNGTO CREEK
TWANTE CANAL

MINISTRY OF NATIONAL PLANNING

GENERAL LOCATION MAP

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P DATE PLATE
CK. BY D.E.C JULY 53 NO. 6

Round Log Costs

Round Log Costs Teak	26,000 c.t. at K280	K72,80,000
Round Log Costs Durables	52,000 c.t. at K220	K1,14,40,000
Round Log Costs Semi-durables	39,000 c.t. at K180	K70,20,000
Round Log Costs Non-durables	13,000 c.t. at K110	K14,30,000
Total Round Log Costs	130,000 c.t. Value	K2,71,70,000

Summary

Total Production Value	K3,67,90,000
Total Round Log Costs	K2,71,70,000
Difference	K96,20,000
Total Production Costs	K50,30,100
Gross Annual Profit	K45,89,900

LABOR COMPARISON BETWEEN PRIVATE MILL AND S.T.B. MILL No. 2.

	Number of Employees	
	60,000 Ton Sawmill	*S.T.B. Mill No. 2*
Supervisory Force	47	45
Operating Labor	634	435
General Office Force	26	14
Round Log Men	75	28
Subtotal	782	522
Shipping and Sales	24	12
Total	806	534
Men per 1,000 Cubic Tons Conversion only	13·0	29·0
Men per 1,000 Cubic Tons Total	13·4	29·7

The State Timber Board Mill No. 2 is an older mill and less efficient than the 60,000 ton mill. In newly established mills, equipped with modern machinery, top supervisory personnel should be employed from abroad to operate the plant until it is well established and Burmese counterparts are trained to fill these positions. It will also be advisable to import operators for special equipment for limited periods to train local operators.

(8) *Recommendations*

(*a*) That a program of improvement in efficiency in existing Government-owned mills be undertaken at once. The program should include re-arrangement of equipment, new units of equipment where needed, and training programs to improve the efficiency of labor.

(*b*) That two European owned mills each having a capacity for converting 60,000 cubic tons of round logs per year be encouraged to reopen operations and to increase the capacities of the mills as the demand for lumber increases.

(*c*) That State Timber Board Sawmill No. 3 be completed, but that no additional facilities be built on this site with the view that the mill will be moved when the requirements of the Port of Rangoon necessitate the use of this area for port development.

(*d*) That plans be made for the construction of a new modern mill of 130,000 cubic tons of round logs per year capacity as the central plant of an integrated forest industry. The site to be selected to provide ample room for the sawmill, joinery works, wall-board mill, veneer and plywood mill, and furniture factory. The construction of the sawmill should be geared to bring in additional capacity as additional supplies become available. The general site plan for the integrated forest products industry must be developed to permit the construction of the joinery, veneer and plywood plant, and lumber treatment before the sawmill is built, since these facilities will be needed prior to the sawmill.

(b) Joinery or woodworking plant. A joinery in which the mass production of wood mill work items such as doors, windows, frames, finishing lumber and other similar units of woodwork may be accomplished, is a necessity for expediting the housing program. This plant should be constructed as a unit of an integrated forest products industry. These materials are now fabricated by hand.

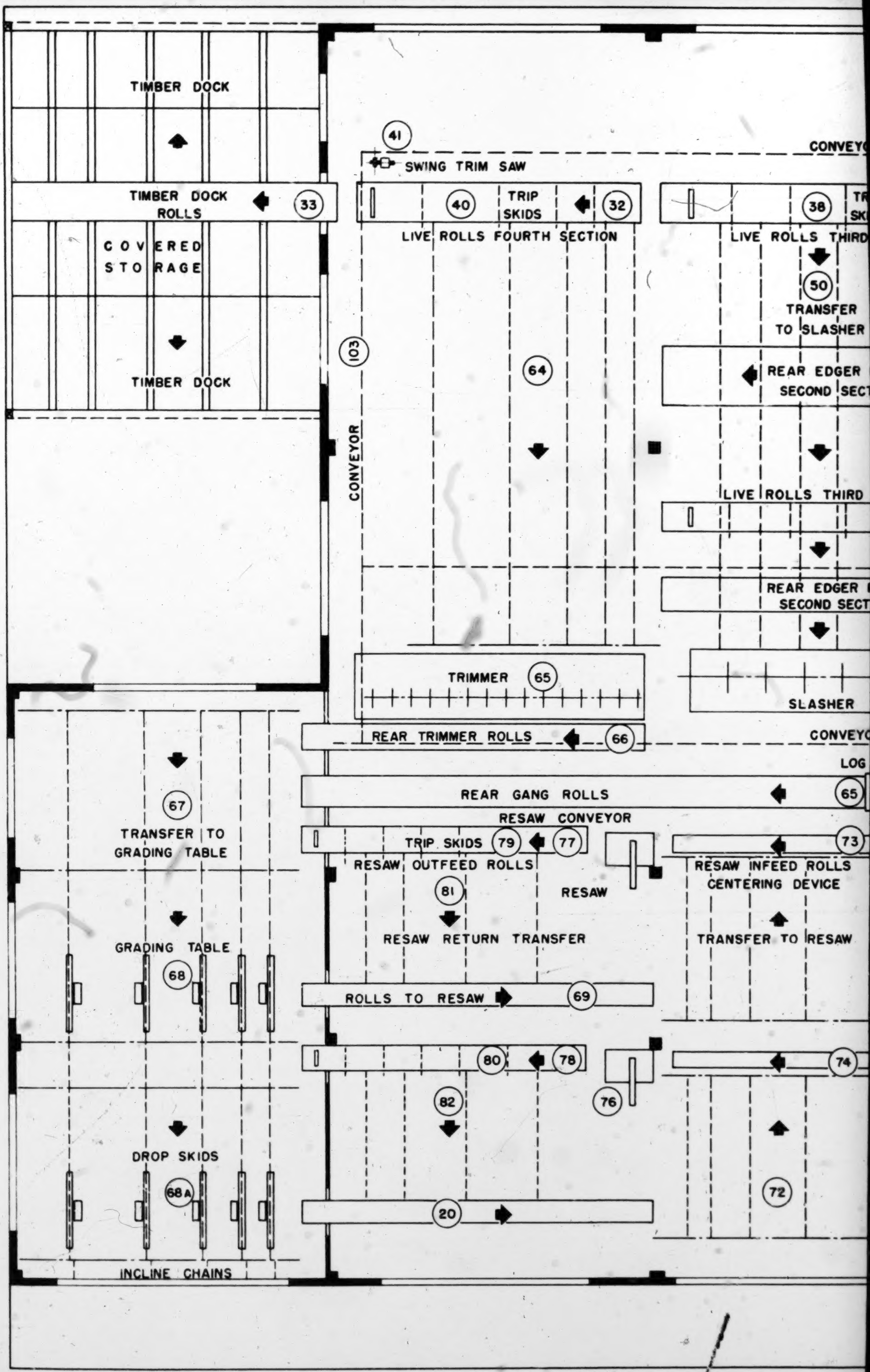
(1) *The market*

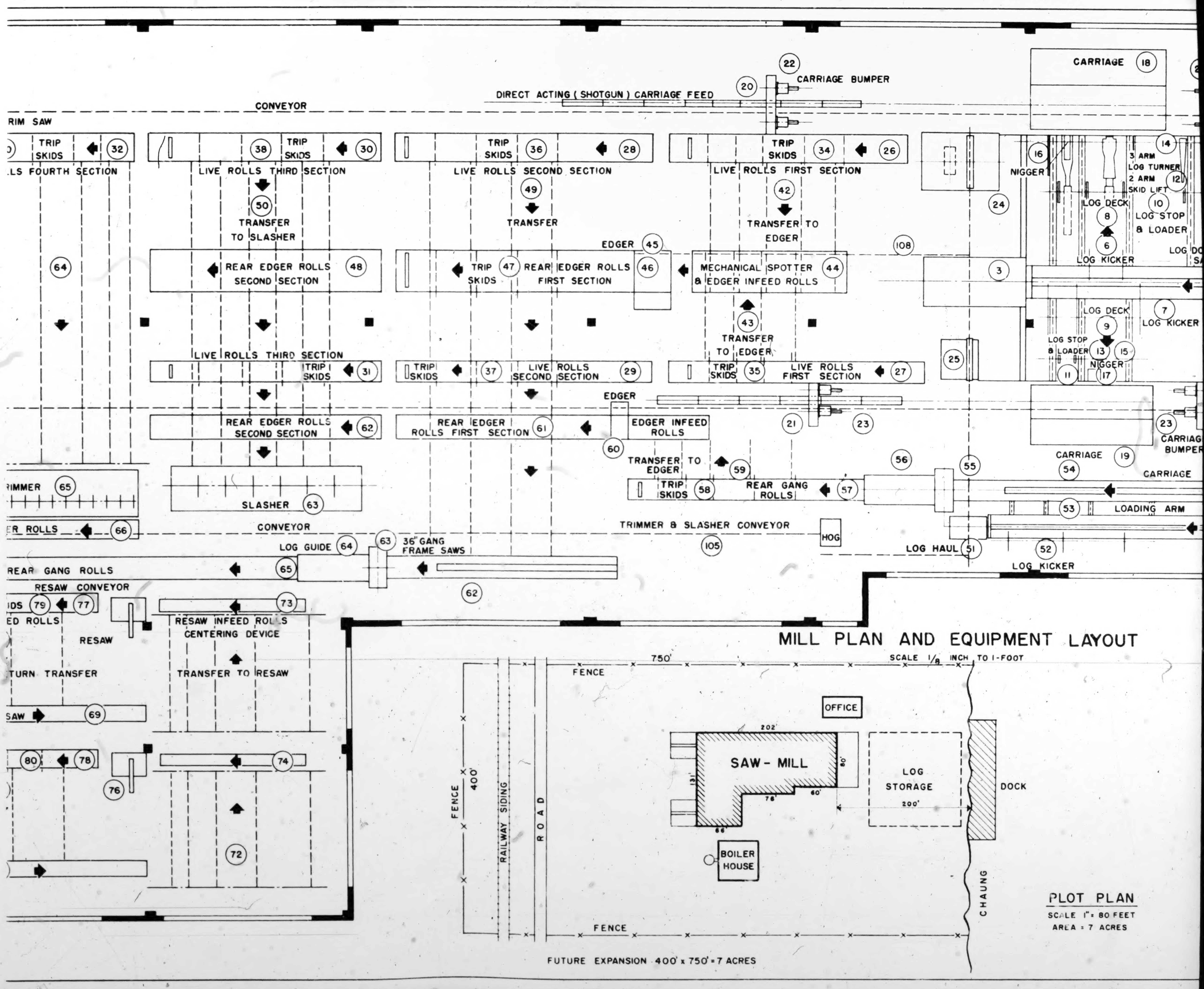
Adequate markets will be available in the housing program. Appreciable savings in the mass production of these items over the present hand method of fabrication will decrease building costs and release skilled labor for the expansion of housing construction.

(2) *Standardization*

There is an obvious need for standardization of many units of building construction. In planning housing units, standard sizes and design of doors, window frames, sash and louvered openings should be established and used throughout the different buildings.

The establishment of such standards should not be difficult to accomplish. The National Housing Board and other boards or departments that have buildings to design and construct could determine the sizes and details of types of mill work items that could be used in any one or all of the buildings. These details when established could be printed on sheets of convenient size with all measurements clearly shown and distributed to architects, designers and the wood working industries. Specifications should be given and tolerances of measurements well defined.


TIMBER DOCK
41
SWING TRIM SAW
CONVEYO
TIMBER DOCK ROLLS
33
40
TRIP SKIDS
32
38
TR SK
LIVE ROLLS FOURTH SECTION
LIVE ROLLS THIRD
COVERED STORAGE
50
TRANSFER TO SLASHER
103
64
REAR EDGER
SECOND SECT
TIMBER DOCK
CONVEYOR
LIVE ROLLS THIRD
REAR EDGER
SECOND SECT
TRIMMER
65
SLASHER
REAR TRIMMER ROLLS
66
CONVEYO
LOG
REAR GANG ROLLS
65
RESAW CONVEYOR
67
TRANSFER TO GRADING TABLE
TRIP SKIDS
79
77
73
RESAW OUTFEED ROLLS
RESAW INFEED ROLLS
CENTERING DEVICE
81
RESAW
RESAW RETURN TRANSFER
TRANSFER TO RESAW
GRADING TABLE
68
ROLLS TO RESAW
69
80
78
74
82
76
DROP SKIDS
68A
72
20
INCLINE CHAINS



MILL PLAN AND EQUIPMENT LAYOUT

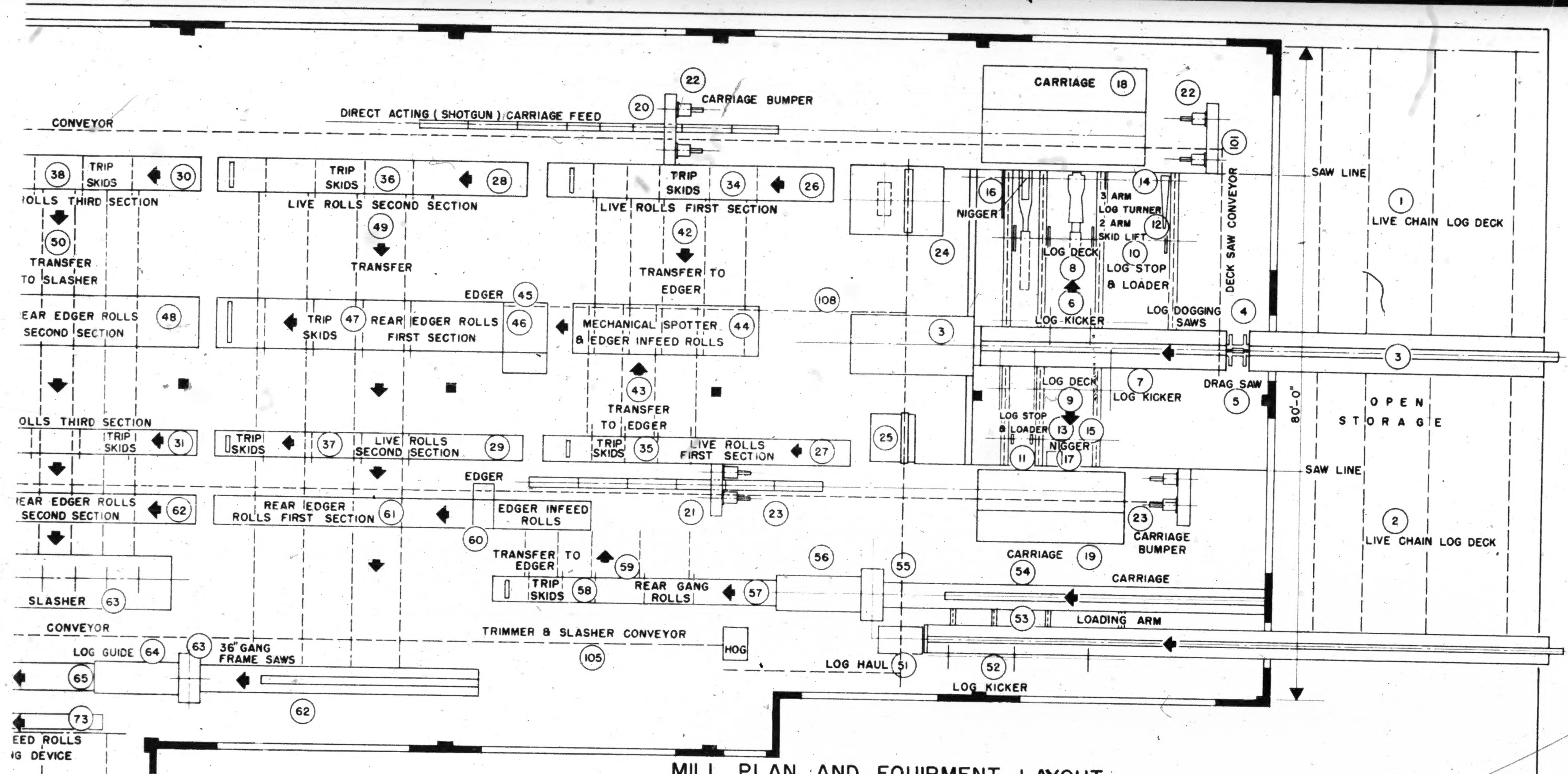
SCALE 1/8 INCH TO 1-FOOT

PLOT PLAN

SCALE 1" = 80 FEET

AREA = 7 ACRES

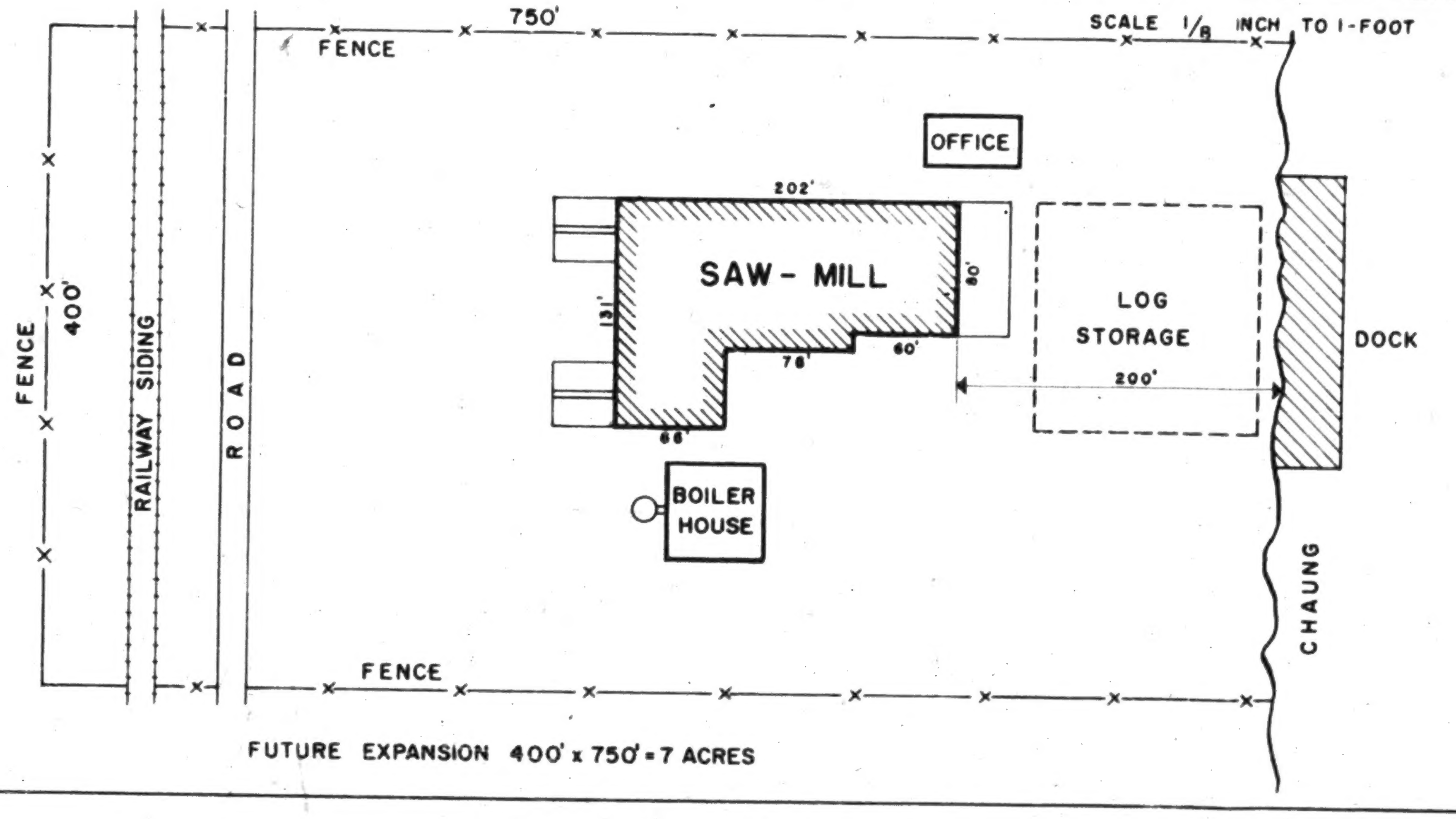
CARRIAGE 18
22
CARRIAGE BUMPER
20
DIRECT ACTING (SHOTGUN) CARRIAGE FEED
CONVEYOR
RIM SAW
TRIP SKIDS 32
LS FOURTH SECTION
38 TRIP SKIDS 30
LIVE ROLLS THIRD SECTION
TRIP SKIDS 36 28
LIVE ROLLS SECOND SECTION
TRIP SKIDS 34 26
LIVE ROLLS FIRST SECTION
14
16 NIGGER
3 ARM LOG TURNER
2 ARM SKID LIFT 12
10
LOG DECK 8
LOG STOP & LOADER
50 TRANSFER TO SLASHER
49 TRANSFER
42 TRANSFER TO EDGER
24
108
6 LOG KICKER
LOG DO
SA
64
EDGER 45
REAR EDGER ROLLS SECOND SECTION 48
TRIP SKIDS 47 REAR EDGER ROLLS FIRST SECTION 46
MECHANICAL SPOTTER & EDGER INFEED ROLLS 44
3
LOG DECK 7 LOG KICKER
9
43 TRANSFER TO EDGER
LOG STOP & LOADER 13 15
NIGGER
11 17
25
LIVE ROLLS THIRD SECTION TRIP SKIDS 31
TRIP SKIDS 37 LIVE ROLLS SECOND SECTION 29
TRIP SKIDS 35 LIVE ROLLS FIRST SECTION 27
EDGER
REAR EDGER ROLLS SECOND SECTION 62
REAR EDGER ROLLS FIRST SECTION 61
EDGER INFEED ROLLS
60
21 23
23 CARRIAGE BUMPER
CARRIAGE 19
TRANSFER TO EDGER 59
56 55
CARRIAGE 54
CARRIAGE
TRIP SKIDS 58 REAR GANG ROLLS 57
53 LOADING ARM
IMMER 65
SLASHER 63
ER ROLLS 66
CONVEYOR
TRIMMER & SLASHER CONVEYOR
HOG
105
LOG HAUL 51
52 LOG KICKER
LOG GUIDE 64
63 36" GANG FRAME SAWS
REAR GANG ROLLS 65
62
RESAW CONVEYOR
IDS 79 77
ED ROLLS
73
RESAW INFEED ROLLS CENTERING DEVICE
RESAW
TURN TRANSFER
TRANSFER TO RESAW
SAW 69
80 78
74
76
72
750'
FENCE
FENCE 400'
RAILWAY SIDING
ROAD
OFFICE
202'
SAW-MILL
131'
80'
78'
60'
66'
LOG STORAGE 200'
DOCK
BOILER HOUSE
CHAUNG
FENCE
FUTURE EXPANSION 400' x 750' = 7 ACRES



CONVEYOR
DIRECT ACTING (SHOTGUN) CARRIAGE FEED
CARRIAGE BUMPER
CARRIAGE 18
SAW LINE
LIVE CHAIN LOG DECK 1
TRIP SKIDS
OLLS THIRD SECTION
LIVE ROLLS SECOND SECTION
LIVE ROLLS FIRST SECTION
NIGGER 16
3 ARM LOG TURNER
2 ARM SKID LIFT
LOG DECK 8
LOG STOP & LOADER 10
DECK SAW CONVEYOR
TRANSFER TO SLASHER 50
TRANSFER 49
TRANSFER TO EDGER 42
EDGER 45
EAR EDGER ROLLS SECOND SECTION 48
REAR EDGER ROLLS FIRST SECTION 47
MECHANICAL SPOTTER & EDGER INFEED ROLLS 44
LOG KICKER 6
LOG DOGGING SAWS 4
OPEN STORAGE
80'-0"
DRAG SAW 5
LOG DECK 9
LOG KICKER 7
LOG STOP & LOADER 11
NIGGER 13 15 17
TRANSFER TO EDGER 43
OLLS THIRD SECTION
LIVE ROLLS SECOND SECTION
LIVE ROLLS FIRST SECTION
EDGER
EAR EDGER ROLLS SECOND SECTION 62
REAR EDGER ROLLS FIRST SECTION 61
EDGER INFEED ROLLS 60
CARRIAGE BUMPER 23
LIVE CHAIN LOG DECK 2
CARRIAGE 19
TRANSFER TO EDGER 59
REAR GANG ROLLS 57
CARRIAGE 54
LOADING ARM 53
SLASHER 63
CONVEYOR
TRIMMER & SLASHER CONVEYOR 105
HOG
LOG GUIDE 64
36" GANG FRAME SAWS 63
LOG HAUL 51
LOG KICKER 52
EED ROLLS
IG DEVICE
TO RESAW

MILL PLAN AND EQUIPMENT LAYOUT

SCALE 1/8 INCH TO 1-FOOT



FENCE
750'
400'
RAILWAY SIDING
ROAD
OFFICE
SAW - MILL
202'
80'
131'
78'
60'
66'
LOG STORAGE
200'
DOCK
BOILER HOUSE
CHAUNG

FUTURE EXPANSION 400' x 750' = 7 ACRES

PLOT PLAN

SCALE 1" = 80 FEET
AREA = 7 ACRES

MINISTRY OF NATIONAL PLANNING

INDUSTRIES
SAW MILL

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY: EJP	DATE	PLATE NO. 7	
CK. BY: DC	MAY 53		

Standardization of mass production would result in saving of materials. Machine made woodwork can make these units to closer tolerances than present hand methods with the result that the members can be of smaller size and stronger. With properly selected machines and equipment, millwork units can be fabricated on a mass production basis at low cost.

The prevailing price of this type of handmade carpentry work averages approximately K5.00 per sq. ft., whereas from the proposed plant the price should average K2.18. There is at present a small amount of machine produced millwork that averages K2.77 per sq. ft. of finished area.

(3) *Raw material requirements*

Converted lumber will be the chief raw material required for this plant. Semi-durable non-teak hardwoods, chemically pretreated to resist deterioration can be used to meet the bulk of the plant's raw material requirements.

For maximum annual production this plant will require approximately 4,500 c.t. of teak, 6,500 c.t. of durable hardwoods, 16,000 c.t. of semi-durable hardwoods, and 3,600,000 sq. ft. of $\frac{3}{16}$-inch plywood. All of these requirements would be supplied from the adjoining plants of the integrated timber industries.

(4) *Cost of raw materials*

In the estimate of production costs, the following prices of converted lumber delivered to the woodworking plant were used: teak K700 per c.t., durables K450 per c.t., and semi-durables K375 per c.t. Plywood costs, as indicated in the project report on the subject, would average K332.74 plus K16.26 for handling and transport, or a total of approximately K349.00 per 1,000 sq. ft. The prices of converted lumber were obtained from marketing sources in Rangoon.

(5) *Description and cost of plant*

The plant should be constructed on the site and adjacent to other recommended lumber and wood products industries, such as sawmills, plywood and furniture plants, so that the whole would be an integrated working unit. The integrated development would result in a substantial saving in construction and operation costs, as the plants would depend on one another for materials. The Rangoon area is proposed because of the availability of power, transportation and markets, and because integration with other allied industries would be possible.

The initial plant layout would require an area of five acres, but an area of ten acres should be provided to allow for expansion. This area would provide:

30,000 sq. ft. for the mill building;
2,600 sq. ft. for lumber storage;
5,000 sq. ft. for covered storage for finished millwork;
20,000 sq. ft. for a railroad siding, roads, and truck loading platforms;
1,600 sq. ft. for boiler and kilns; and
1,500 sq. ft. for the mill office.

Location and plant layout are shown on Plates 6 and 8.

TABLE XXII – 9

COST ESTIMATE FOR WOODWORKING PLANT

Cost of equipment, delivered Rangoon	K10,92,500
Erection of Plant	1,18,750
Kilns for wood preparation	71,250
Equipment foundations	64,125
Buildings	12,90,000
Total costs	K26,36,625
Land cost and site improvement 5%	1,31,875
Total	K27,68,500

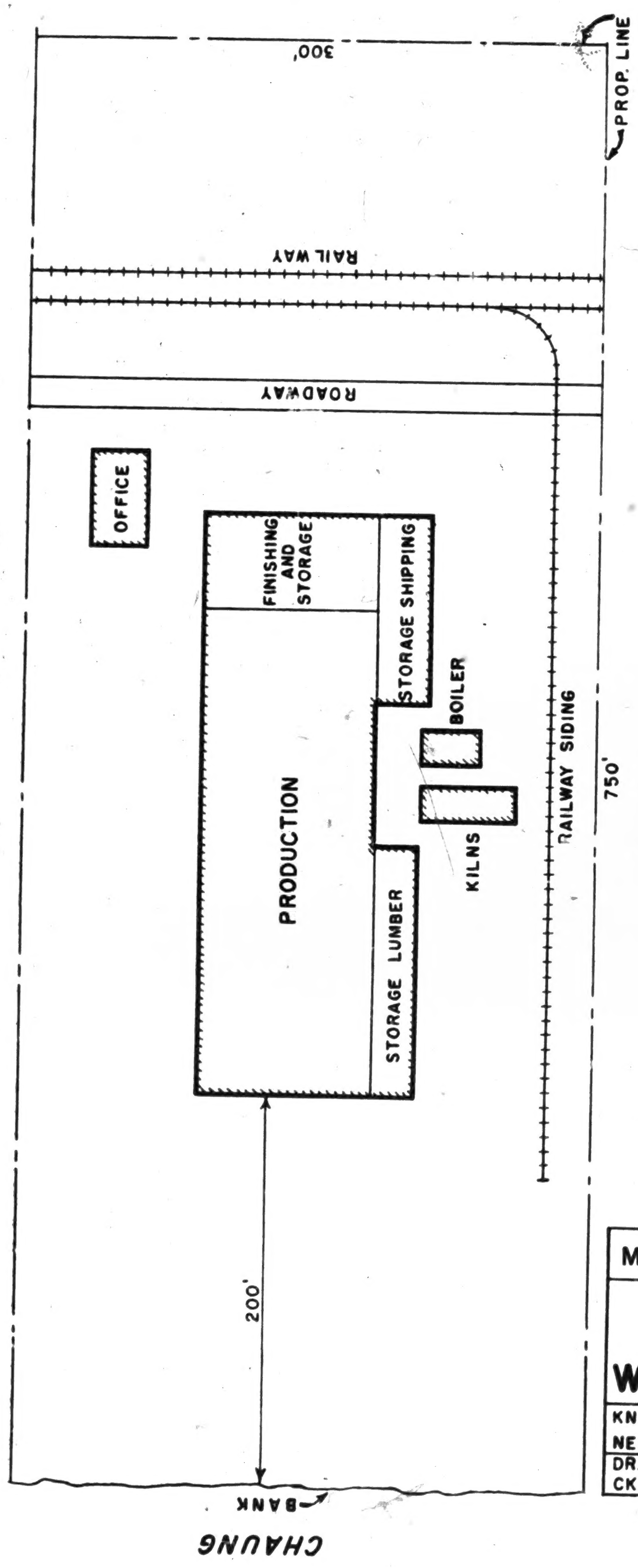
The estimate is based on proposals and recommendations received from US equipment manufacturers who are designers and builders of specialized woodworking machinery. The estimate assumes that all equipment will be purchased in United States dollars, but similar equipment may be procured from sterling areas. The buildings are of light steel-frame construction with corrugated asbestos sides and roof, and may be purchased in sterling currency.

Approximately K11·0 lakhs of purchases will be in dollars and about K5·0 lakhs in sterling currency. The balance of K10·4 lakhs is in kyats. Dollar costs could be reduced by purchasing part of the equipment from the sterling area, if it is available from that source.

(6) *Costs of production*

The estimated annual operational costs for the production of millwork items (Table XXII–10, *see p. 743*) have been based on the quantities shown in Table XXII–11 (*see p. 743*). The output of the plant was estimated at approximately 50% of the equipment capacity as stated by the manufacturers. This conservative estimate of production is made for a period of the first year to allow for the training of local personnel. These production costs are based on operating the plant one shift a day. The employees required to operate the plant are:

Management and superintendence	5
Supervisory	14
Skilled workmen	40
Office, shipping and stores	20
Unskilled workmen	150
Total	229


300'
PROP. LINE
RAILWAY
ROADWAY
OFFICE
FINISHING AND STORAGE
STORAGE SHIPPING
BOILER
PRODUCTION
KILNS
RAILWAY SIDING
750'
STORAGE LUMBER
200'
BANK
CHAUNG

PLOT PLAN

SCALE:- 1" = 80'

MINISTRY OF NATIONAL PLANNING

INDUSTRIES

JOINERY OR WOODWORKING PLANT

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK. RANGOON

DR. BY E.J.P.	DATE	PLATE
CK. BY D.C.	JUNE '53.	NO. 8

Adequate skilled and unskilled labor is available in the Rangoon area. A very limited management group from abroad would be required to manage and operate the mill during the first five years of operation.

TABLE XXII – 10

ESTIMATED ANNUAL PRODUCTION COSTS

Interest and Amortization on Buildings (20 yrs. at ·07358) 15·4 lakhs				*K* 1,13,300
Interest and Amortization on equipment (15 yrs. at ·08994) 11·0 lakhs				99,000
Power costs 600,000 kWh at K0.20				1,20,000
Kiln operations (fuel costs) 570 at 300 days				1,71,000
Material costs (Timber)			*K*	
Teak	4,500 c.t.	at K700	31,50,000	
Durables	6,500 c.t.	at K450	29,25,000	
Semi-durables	16,000 c.t.	at K375	60,00,000	
Plywoods	3,600 m.s.f.	at K344	12,56,400	
				1,33,31,400
Material costs (imported)				
Nails	250 cwt.	at K50	12,500	
Metal fittings	200 cwt.	at K70	14,000	
Glue	212,000 lbs.	at K2	4,24,000	
Glass	5,000 boxes	at K60	3,00,000	
Pretreatment	16,000 c.t.	at K13	2,08,000	
				9,58,500
General Office expense 8,000 m.s.f. at K 2.00				16,000
Workshop and Stores 8,000 m.s.f. at K10.00				80,000
Labor costs				
Supervisory			1,39,740	
Office			2,37,680	
Operations			4,97,520	
Miscellaneous			74,400	
				9,49,340
Plant maintenance 5% of K12,82,500				64,160
Operational contingencies 10%				15,07,300
Total				1,74,10,000

The estimated annual production of the plant and its value, based on prevailing selling prices for machine made products are given in Table XXII-11.

TABLE XXII – 11

		K
Glazed sash	1,500,000 s.f. at K3.00	45,00,000
Louvered openings	2,500,000 s.f. at K2.80	70,00,000
Panelled doors	1,350,000 s.f. at K3.20	43,20,000
Millwork items (Partitions, cupboards, etc.)	2,650,000 s.f. at K2.40	63,60,000
	Total value	2,21,80,000
	Total operational costs	1,74,10,000
	Gross annual profit	47,70,000

(7) *Recommendations*

The preliminary planning, selection of site, and placing of purchase orders for the equipment could be completed by October 1, 1953. Detailed design and drawings, could be completed and ready for tenders for construction by December 1953. Manufacturers have stated there should be no delay in shipment of machinery. Delivery of equipment to Rangoon can be made by March 1954. Expenditures would have to be appropriated for local payrolls and development of the project locally. An initial K1·0 lakh would be sufficient. By June 1954, the remainder of K9·4 lakhs should be available. Construction of the buildings and installation of equipment can be completed by August 1954.

(c) Veneer and plywood plant. The advantages of using plywood over other types of construction material are many. Properly made plywood has greater strength and rigidity than any other building or construction material of equal weight and thickness. Some of the versatile features of this product are: ready workability, large panel sizes, light weight, dimensional stability, exceptional strength, resistance to splitting, resistance to puncture.

(1) *The market*

(*a*) Adequate markets are available for the annual 20,000,000-square-foot output (on a two-shift, 300-days-per-year basis) of the proposed plant. Manufacture of doors, interior partitions, and panelling for the housing program will require an estimated 20,500,000 sq. ft. of plywood annually. The present demand for tea chests is approximately 450,000 sq. ft. annually, and is expected to increase within the next few years to about 750,000 sq. ft. There will be a market for additional quantities of plywood for furniture and other purposes.

(*b*) The proposed plant could produce another specialized veneer by rotary cutting of logs into veneer for manufacturing baskets, boxes and other containers suitable for packing fruits, vegetables and similar commodities. Because of comparatively greater thickness at which veneer for this purpose is produced, it is usually referred to as "rotary-cut lumber."

(2) *Domestic production of plywood*

Plywood can be produced in Burma at less than the cost of the imported product. The estimated production cost of $\frac{3}{16}$-in. plywood is approximately K333 per 1,000 sq. ft., compared with imported $\frac{3}{16}$-in. plywood delivered in Rangoon at K704.80 per 1,000 sq. ft. Much of the imported plywood is not well suited to tropical conditions, while plywood to be manufactured in the proposed plant will be cemented with waterproof urea or phenol glues. The indigenous product will therefore be superior in quality.

There are many items that can be made of plywood in whole or in part and which will contribute materially to the nation's economy. They include:

(*a*) Housing; wall sheeting and panelling, subfloors, partitions, doors;

(*b*) Furniture, cabinets;

(*c*) Industrials; packing and display cases, counters, filing cabinets, instrument panels, drafting tables;

(*d*) General construction; concrete forms, structurals, temporary walls and fences, temporary roofing and work tables;

(*e*) Transportation, railroad cars, truck lining and sheathing;

(*f*) Tea chests, boats, toys, recessed lighting, parade floats.

(3) *Raw material requirements*

Some of the less valuable merchantable woods can be used for the manufacture of veneers and plywoods. Taungthayet and kanyin woods have been found suitable. There is an abundance of these and other woods in Burma that are suitable for the manufacture of plywoods. Their use would result in a better utilization of the timber resources of the country. It is estimated that this plant, under maximum production, will require about 17,000 cubic tons of round logs annually. The estimated cost of these logs delivered Rangoon is K125 per cubic ton.

(4) *The plant*

The plywood plant should be constructed on the same site and adjacent to a modern joinery plant, which is proposed herein in a separate report. The joint use of such facilities as drying kilns, railroad sidings and storage areas would permit appreciable economy in both construction and operation. The woodworking plant would use a substantial amount of plywood for fabricating doors and cabinets; consequently, the joint use of the site would minimize plywood handling costs. The location is proposed for the Rangoon area because of the availability of power, transportation and markets.

As recommended in other reports, a site should be chosen in an area that would be large enough (approximately 35 acres) to accommodate the complete development of an integrated wood products industry. At this site an area of at least 7½ acres should be provided for the plywood plant; a 15-acre site would be preferable to provide for future expansion.

Most of the equipment for a plywood plant is immediately available from storage in Singapore and can be purchased at 1946 prices. The equipment is primarily for a veneer and cutting plant, and an additional drier and press would be needed for the mass production of plywood. For location and plant layout, see Plates 6 and 9.

(*a*) *Estimated costs.* The estimated costs for this plant, which is rated at 20,000,000 sq. ft., annually, are given in Table XXII–12.

TABLE XXII – 12

COST ESTIMATE FOR PLYWOOD PLANT

	K
Cost of equipment f.o.b., Singapore	9,55,000
Cost of handling and shipping to Rangoon	50,000
Cost of equipment erection, Rangoon	4,50,000
Cost of additional drier and press	3,00,000
Cost of erection drier and press	1,20,000
Cost of equipment foundations	65,000
Cost of buildings	6,90,000
Total cost of plant	26,30,000
Land costs and site improvements 5%	1,31,500
Total	27,61,500

The above figures of the cost of the plant f.o.b., Singapore, are negotiating figures as quoted by the owner. All of the above costs can be paid in kyats with the exception of K3,00,000 for the additional drier and press and some construction materials, to be purchased in sterling. All of the equipment was originally purchased in the United States and it is therefore advisable to purchase the new drier (3 lakhs) from the same source so that the plant will be uniform in operation. Construction materials, such as steel frame buildings and corrugated cement-asbestos sheets, can be purchased in sterling for approximately K4,50,000.

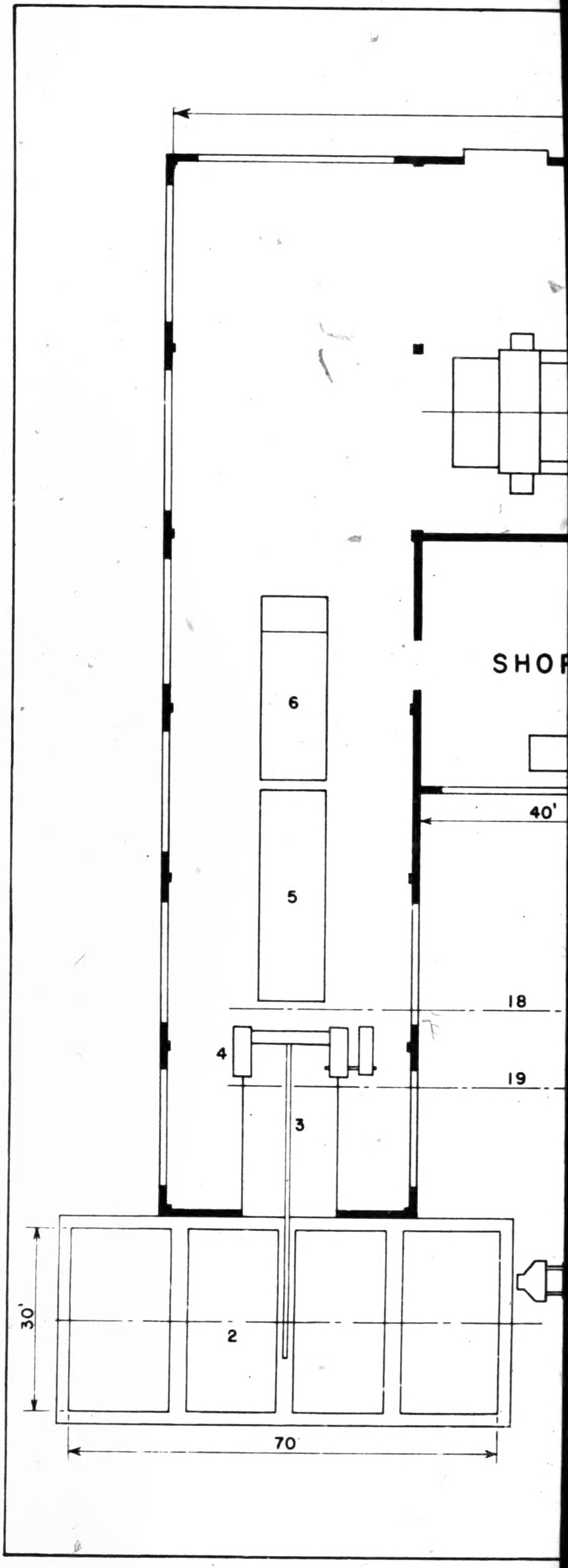
(*b*) *Personnel requirements.* The operation of this plant will require approximately 197 employees, distributed as indicated in Table XXII–13.

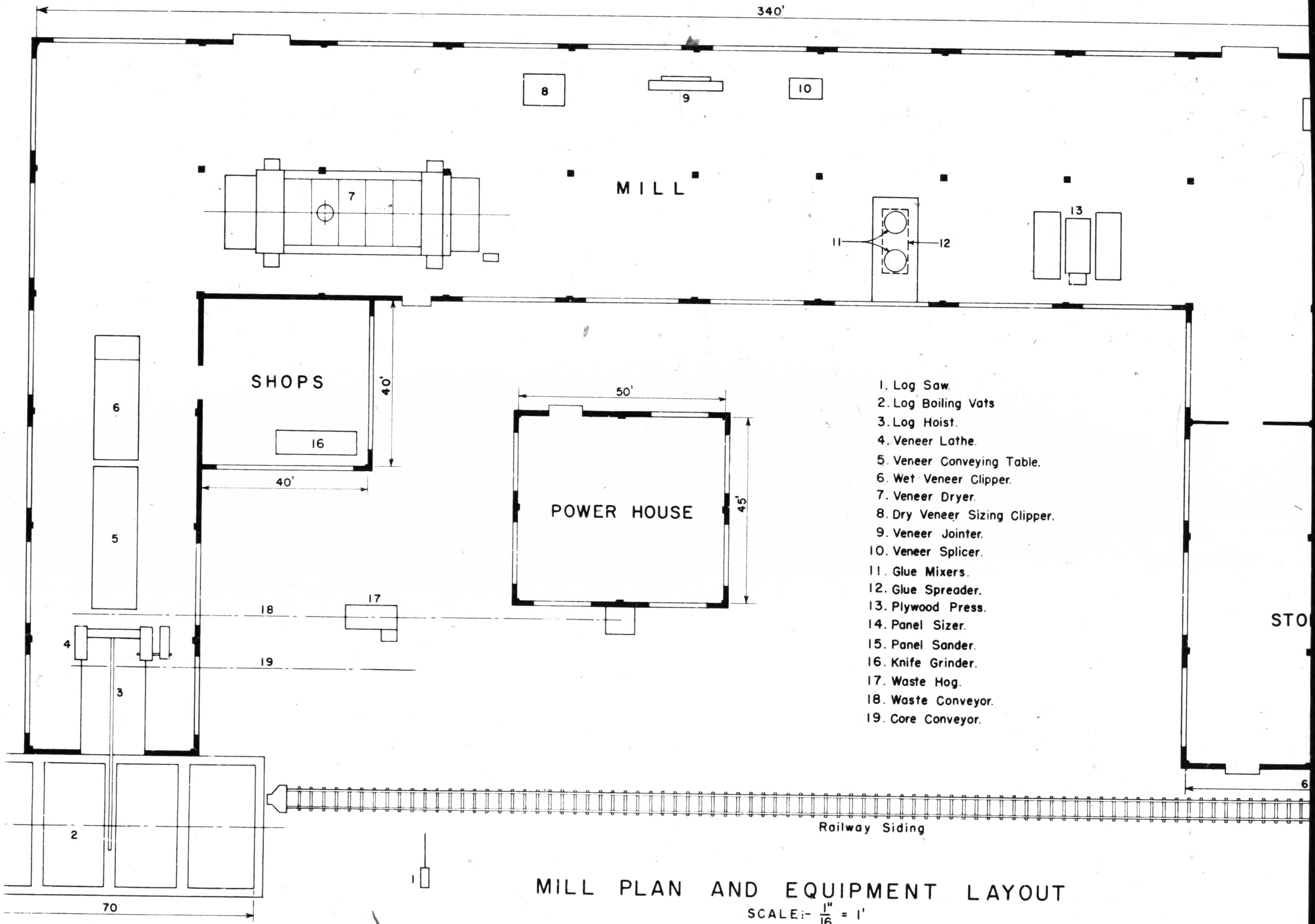
TABLE XXII – 13

PLYWOOD PLANT PERSONNEL

Plant manager and supervisory force	10
Office supervisory, accountants, clerks and stenographers	40
Skilled workmen	52
Semi-skilled workmen	35
Unskilled workmen	60
	197

Adequate skilled and ordinary labor to operate the plant are available in Rangoon. A small management group from abroad would be required to manage and operate the plant during the first five years of operation.


SHOP

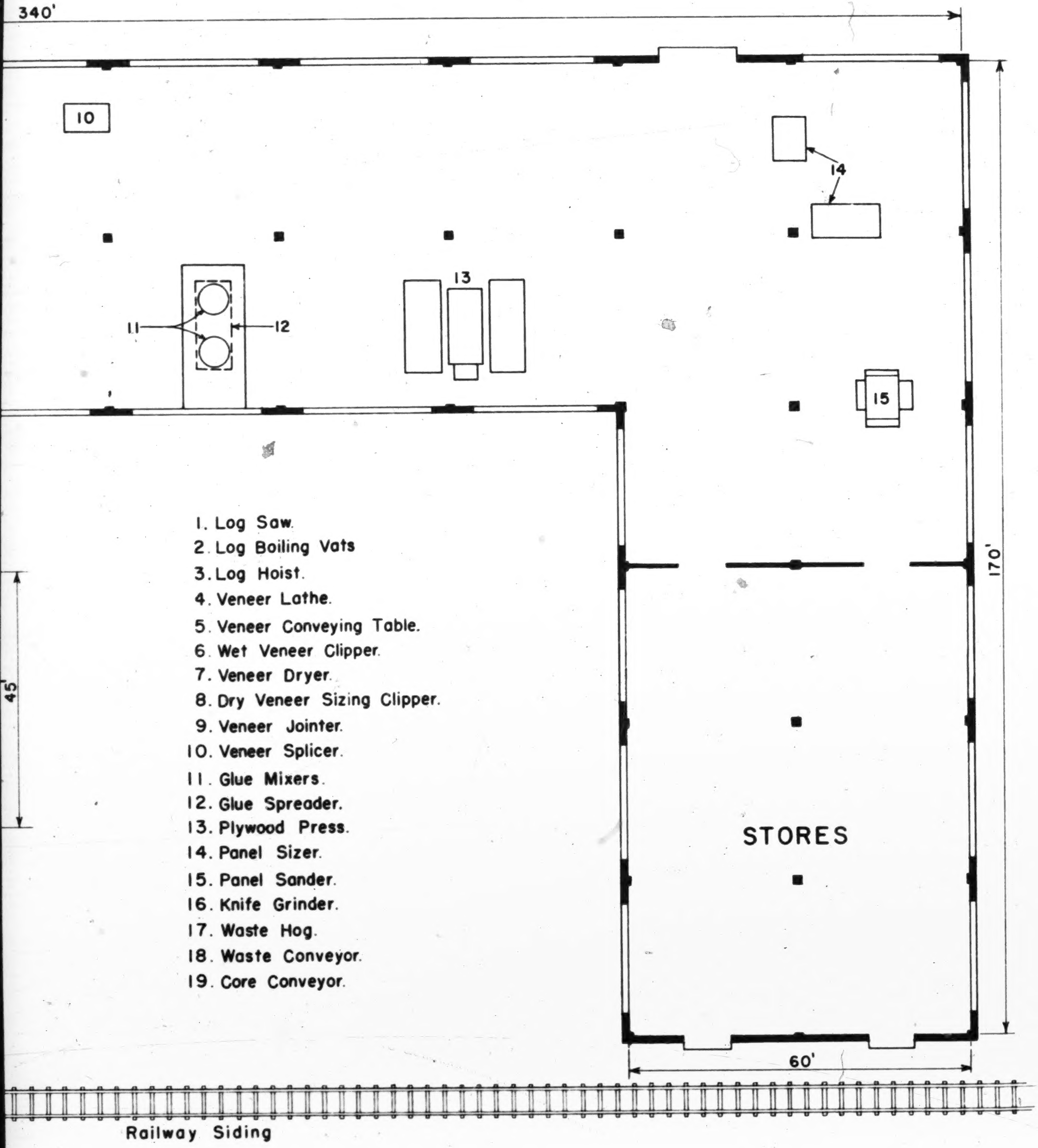


340'
8
9
10
MILL
7
11
12
13
SHOPS
40'
16
40'
6
5
50'
POWER HOUSE
45'
17
18
4
19
3
2
70
1
Railway Siding
STO
6

1. Log Saw.
2. Log Boiling Vats
3. Log Hoist.
4. Veneer Lathe.
5. Veneer Conveying Table.
6. Wet Veneer Clipper.
7. Veneer Dryer.
8. Dry Veneer Sizing Clipper.
9. Veneer Jointer.
10. Veneer Splicer.
11. Glue Mixers.
12. Glue Spreader.
13. Plywood Press.
14. Panel Sizer.
15. Panel Sander.
16. Knife Grinder.
17. Waste Hog.
18. Waste Conveyor.
19. Core Conveyor.

MILL PLAN AND EQUIPMENT LAYOUT

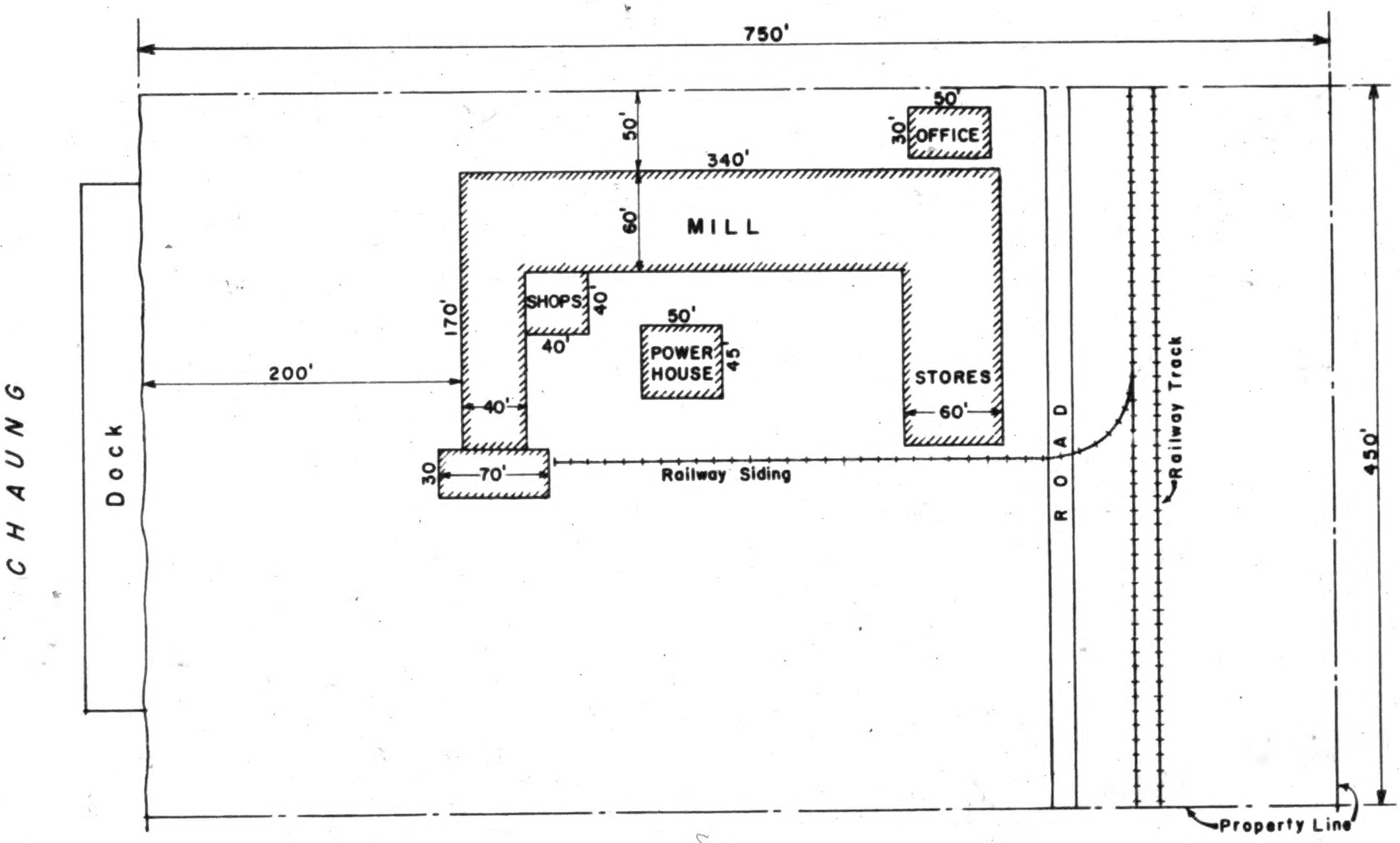
SCALE:- $\frac{1''}{16} = 1'$


340'
10
14
13
11
12
15
170'
45
STORES
60'
Railway Siding

1. Log Saw.
2. Log Boiling Vats
3. Log Hoist.
4. Veneer Lathe.
5. Veneer Conveying Table.
6. Wet Veneer Clipper.
7. Veneer Dryer.
8. Dry Veneer Sizing Clipper.
9. Veneer Jointer.
10. Veneer Splicer.
11. Glue Mixers.
12. Glue Spreader.
13. Plywood Press.
14. Panel Sizer.
15. Panel Sander.
16. Knife Grinder.
17. Waste Hog.
18. Waste Conveyor.
19. Core Conveyor.

ND EQUIPMENT LAYOUT

SCALE:- $\frac{1''}{16} = 1'$


750'
50'
30'
OFFICE
50'
340'
60'
MILL
SHOPS
40
40'
50'
POWER HOUSE
45
170'
200'
40'
STORES
60'
30
70'
Railway Siding
ROAD
Railway Track
450'
Property Line
Dock
CHAUNG

PLOT PLAN
SCALE:- 1" = 80'

MINISTRY OF NATIONAL PLANNING

INDUSTRIES

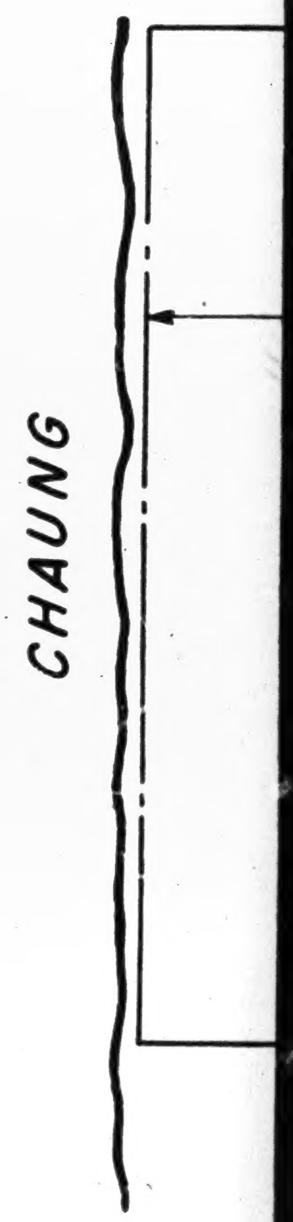
PLYWOOD PLANT

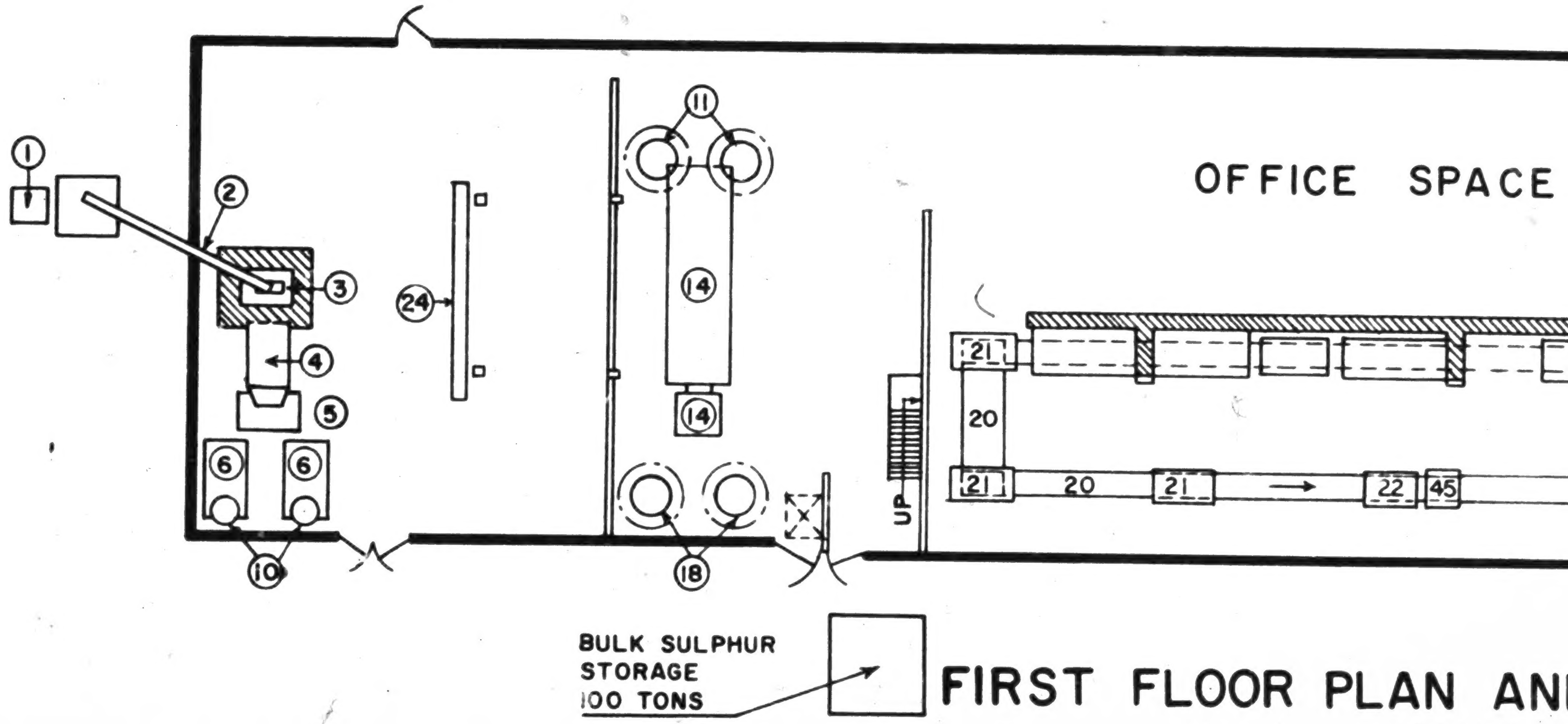
KNAPPEN TIPPETTS ABBETT ENGINEERING CO.,
NEW YORK RANGOON

DR. BY E.J.P. DATE PLATE
CK. BY D.C. MAY 1953 NO. 9

MACHINERY AND EQUIPMENT LIST

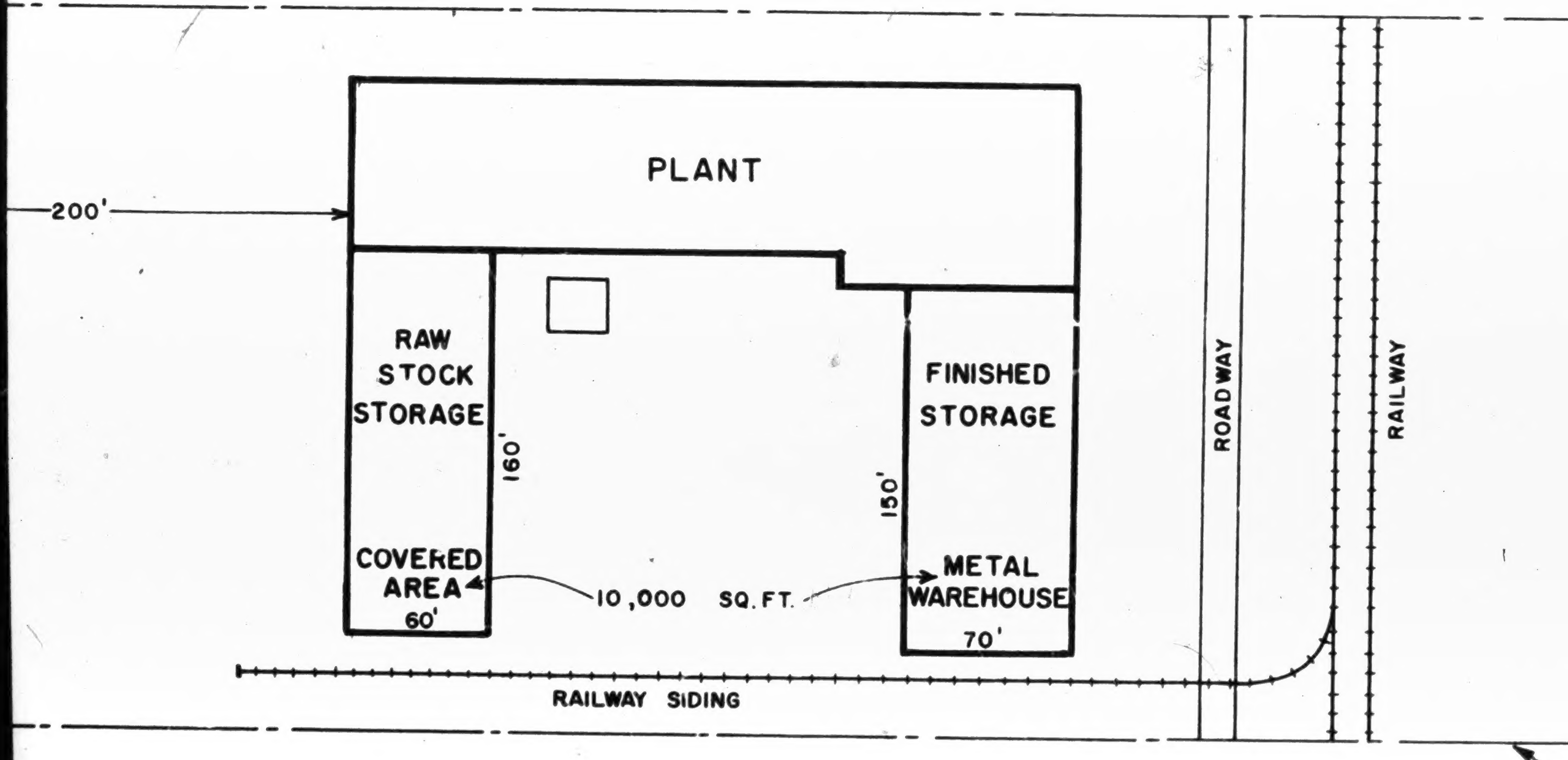
ITEM NO	DESCRIPTION
1	CONVEYOR FOR PNEUMATIC BLOWER FOR CARRYING SAWDUST TO STORAGE BINS; TRACTORS AND TRAILERS FOR WOOD YARD; BARKER, IF REQUIRED, FOR GREEN WASTE.
2	MITTS AND MERRILL NO.7 HOG WITH 20 HP MOTOR.
3	FEED TROUGH WITH GEARED MOTOR, 1/2 HP, 60 RPM TO FEED SECOND GRINDER.
4	36 INCH BAVER BROS. ATTRITION MILL WITH ALL ACCESSORIES.
5	SUCTION BLOWER FOR GROUND MATERIAL AND CYCLONE.
6	VIBRATING SCREENS, FOR ASSURING CONSTANT MESH MATERIAL.
10	DRYER, CAPACITY 6,000 POUNDS OF SAWDUST PER HOUR, REMOVING 2,000 POUNDS OF WATER PER HOUR.
11	BLOWER AND SILO FOR DRY GROUND WOOD.
14	ONE WOOD CHEMICAL BIN AND DISCHARGE MECHANISM.
16	GRAVIMETRIC WEIGHTOMETER FOR GROUND WOOD.
18	MIXING MACHINE.
20	AUTOMATIC SCALE FOR FILLING PANS.
21	SPREADER AND PAN FILLING MACHINE.
22	40 SURFACE PLATES (COLD ROLL STEEL)
23	50 TRANSPORT PLATES, 21 WEAR PLATES.
24	COMPLETE AUTOMATIC PAN CONVEYOR SYSTEM.
25	440 GALVANIZED IRON SCREENS.
26	2 WASHING TANKS FOR SURFACE PLATES AND SCREENS.
27	POLISHING MACHINE FOR SURFACE PLATES.
28	VENTILATORS.
29	HYDRAULIC PRESS, 20 OPENING.
30	PLATE COOLING CAR.
31	PLATE COOLING ROOM.
32	SHEET CAR AND LIFT TRUCK.
40	2 GEARED MOTORS, 3HP, 60RPM.
44	ELECTRICAL SWITCH BOARD.
45	SUCTION FAN FOR SAWDUST COMPLETE WITH PIPING. AND CYCLONE.
47	AUTOMATIC GRINDING MACHINE (HAMMER MILL)
60	FIVE THICKNESS GAGES.
61	STOP WATCH.
62	SMALL CIRCULAR SAW.
63	DRYING OVEN.




1
2
3
24
11
14
14
4
5
6
6
10
18
OFFICE SPACE
21
20
21
20
21
22
45
UP
BULK SULPHUR STORAGE 100 TONS

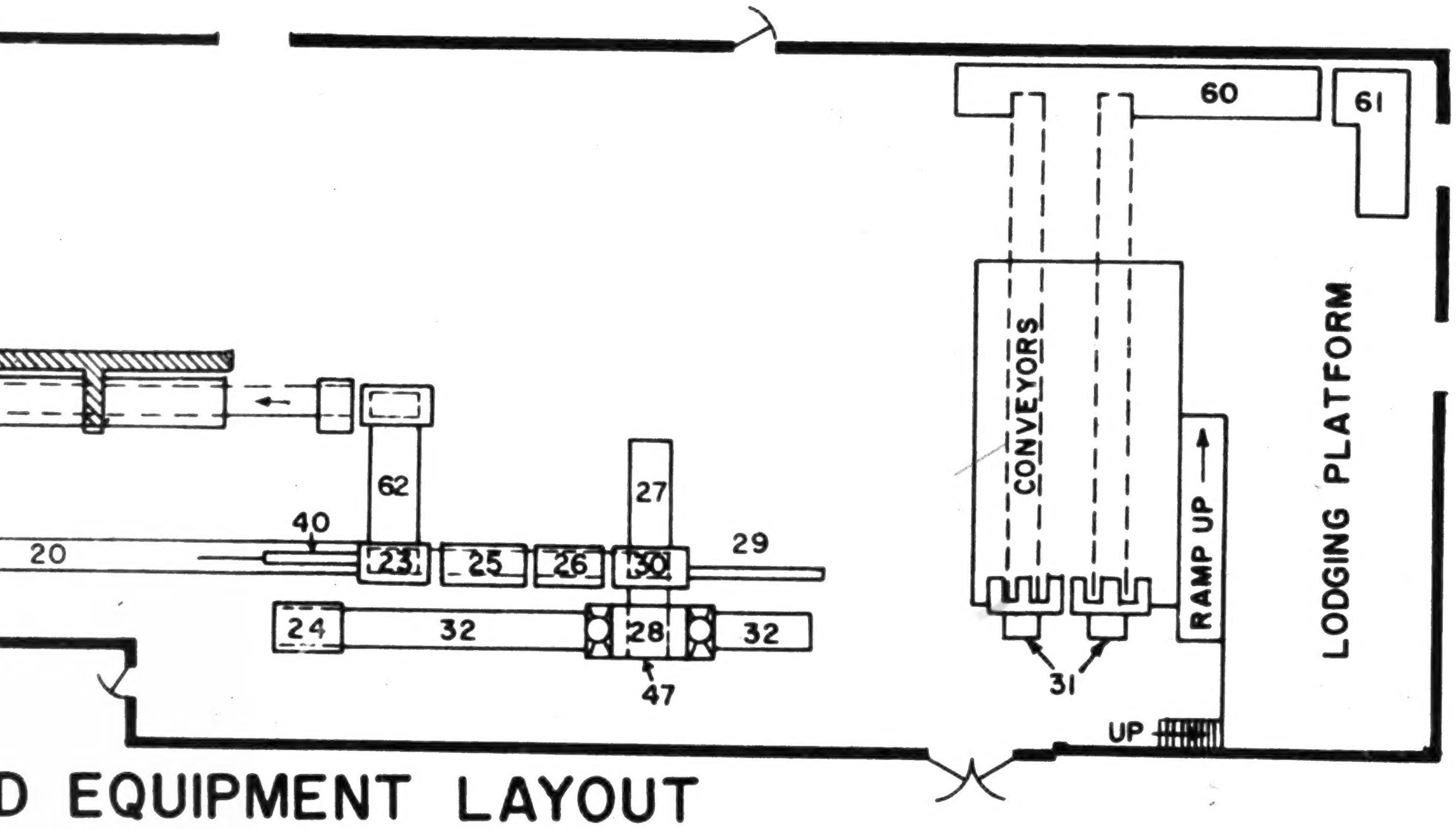
FIRST FLOOR PLAN AN

SCALE 1

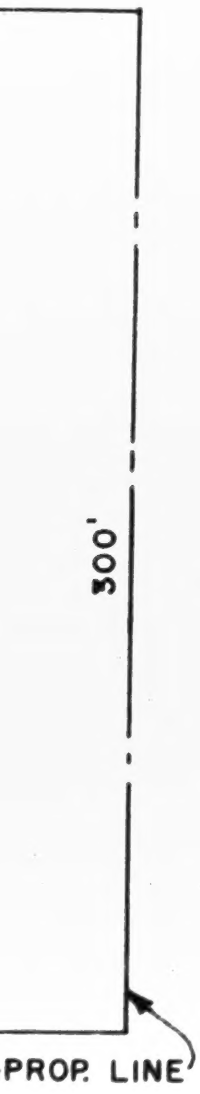

200'
PLANT
RAW STOCK STORAGE
COVERED AREA
60'
160'
10,000 SQ. FT.
150'
FINISHED STORAGE
METAL WAREHOUSE
70'
ROADWAY
RAILWAY
RAILWAY SIDING

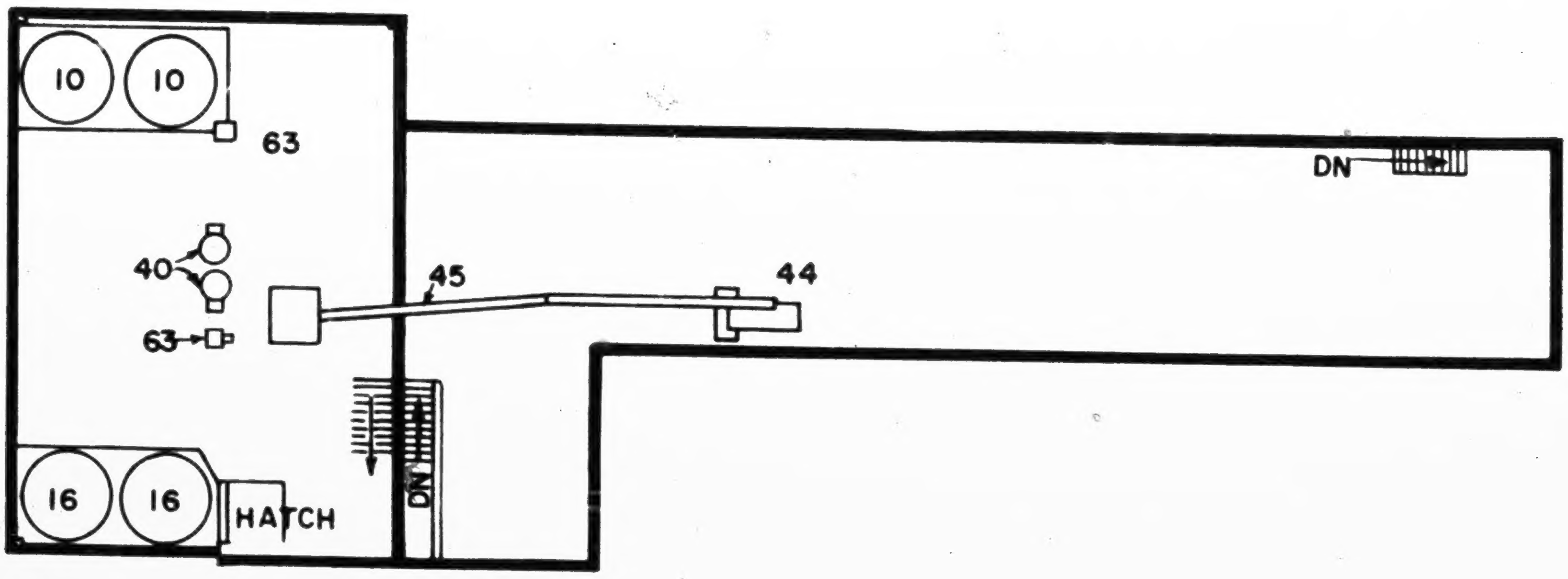
PLOT PLAN

SCALE 1" = 80'


60
61
CONVEYORS
LODGING PLATFORM
RAMP UP
62
27
40
20
23
25
26
30
29
24
32
28
32
47
31
UP

D EQUIPMENT LAYOUT
" = 25'


300'
PROP. LINE


10
10
63
40
63
45
44
DN
16
16
HATCH
DN

SECOND FLOOR PLAN
SCALE 1" = 25'

MINISTRY OF NATIONAL PLANNING

INDUSTRIES

WALLBOARD PLANT

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON.

DR. BY. E.J.P. DATE
CK. BY. D.E.C. MAY 53.
PLATE NO 10

(*c*) *Cost of production.* The estimated costs of manufacturing plywood per 1,000 sq. ft. of panels $\frac{3}{16}$-in. in thickness are indicated in Table XXII–14.

TABLE XXII – 14

ESTIMATED PRODUCTION COSTS—PLYWOOD

	K
Interest and amortization (based on 20 years at ·07358)	9.68
Timber costs at K125 per cubic ton	106.88
Direct labor	18.00
Supervision	6.00
General office expense	0.50
Workshop, stores, etc.	3.50
Power costs (electrical)	14.73
Boiler costs	3.20
Glue (best urea or phenol)	140.00
Operational costs, contingencies 10%	30.25
Total cost per 1,000 sq. ft.	332.74

Using the present imported costs of $\frac{3}{16}$-in. plywood the average gross saving to the economy of Burma will be approximately as follows:

Imported plywood 20,000 m.s.f. at K704.80	K1,40,96,000
Plywood from this plant 20,000 m.s.f. at K332.74	K66,54,800
Difference	K74,41,200
Customs charges on imported plywood	K35,34,000
Gross profit	K39,07,200

(5) *Recommendations*

The objective of this project is the establishment of a manufacturing plant as a unit of an integrated program to produce a product from otherwise unmerchantable indigenous woods. Plywood has become one of the most diversified construction materials developed in recent years. Waterproof adhesives and methods of manufacture have expanded its usefulness many times. Its use results in a great saving in wood. For many of its uses there is no substitute. It is recommended that this project be approved and implemented in the near future.

(d) **Wallboard plant.** In the study of an integrated wood products industry, the implementation of a wallboard manufacturing plant is of prime importance to reduce timber conversion losses by transferring mill wastes and non-merchantable indigenous woods into a useful product immune to fungus and insect attack.

(1) *The market*

Wallboard is used in housing construction for ceilings, partitions, backing for cabinets, and many other purposes. Other products that are competitive in some respects are covered in other sections of this Report, namely, plywood and asbestos-cement board. The use of these other products has been established in Burma and it is possible that a promotional program would have to be undertaken to demonstrate the practicability of wallboard. The expanded housing program will eventually be able to use the output of all the proposed plants.

(2) *The process*

Boards can be made from many species of hard and soft woods, from wood waste in the form of sawdust, shavings, slabs (both with and without bark), and from bagasse, coconut fibers, and other vegetative wastes. The operation requires no pre-treatment, wet treatment, or processing outside the press. The fibers or granules in the form of sawdust or ground material are simply dry-mixed with a few per cent of a readily available and common chemical material which has as its function the "activation" of the lignin in the wood to make it serve as a binder again as it did in the original wood. This chemical is not a binder or resin in itself; and its cost is not more than a small fraction of a cent per square foot of board produced. This dry mixture is spread by automatic machinery onto a plant which is charged into a hydraulic press having multiple heated platens. The time of pressing is approximately ten minutes, more or less, depending on the thickness of the board to be made. The chemical reaction occurs between the added chemical and the lignin present in the wood to form a hard, strong, water-resistant board. The entire processing time from the raw wood waste to the finished board may be only a matter of minutes, and it is no more complicated than sawmilling or other lumbering operations. No chemical or technical supervision is required.

(3) *The plant*

The wallboard plant should be constructed on the site proposed for other units of the integrated forest products plant such as sawmill, joinery, furniture and plywood, so that the wastes from these plants could be utilized in the production in this plant. For location and plant layout see Plates 6 and 10.

The estimated costs for this plant, which is rated at approximately 25,000,000 sq. ft. annually, are given below:

	K
Cost of machinery—f.o.b., United States	22,13,500
Packing, freight, insurance, etc., to Rangoon	3,51,500
Erection of equipment in Rangoon	4,27,500
Equipment foundations	64,125
Buildings and storage areas	13,50,000
Miscellaneous items and contingencies	6,61,675
Total Costs	50,68,300
Land costs and site improvements 5%	2,51,700
Total	53,20,000

The estimate is based on proposals and recommendations received from United States equipment manufacturers who are designers and builders of such specialized production machinery, and on purchase in dollars. The buildings, which are of light steel frame construction with corrugated asbestos sides and roofs, can be purchased in sterling currency. The foreign exchange will amount to approximately 27·0 lakhs of purchases in US dollars and about 9·0 lakhs in sterling currency. The balance of 14·7 lakhs is in kyats. Dollar costs could be reduced somewhat by purchasing part of the equipment from the sterling area, if it is available from that source.

The estimated costs of manufacturing wallboard per 1,000 sq. ft. are given below:

	K
Interest and amortization (20 yrs. at ·07358)	15.00
Electrical power	65.55
Steam power	9.03
Water	0.48
Maintenance and supplies	24.50
Supervision	19.48
Labor	38.57
Wood waste	6.70
Added materials	15.20
Operating contingency	17.49
Total	212.00

The estimated annual production of the plant and its value, based on prevailing selling prices of wallboard imported in Rangoon is as follows:

	K
Wallboard at K500×25,000 sq. ft.	1,25,00,000
Custom charges on imported wallboard	37,50,000
Difference	87,50,000
Wallboard produced in this plant 25,000 m. sq. ft. at K212	53,60,000
Gross Profit	33,90,000

(4) *Raw materials*

The raw material requirements for this plant are estimated at approximately 7,200 tons of saw dust and wood waste annually. The sources of supply are from the rejected wood wastes of other wood processing plants in the Rangoon area. Present price of saw dust waste is K14 per ton, and the wood price (now usually used as firewood) is K25 per ton. These prices are quoted as f.o.b. their source.

(5) *Employment*

The project would directly create additional employment. Indirectly, in its effect on cabinet work and housing construction, it would also probably lead to a net increase in employment. The operation of this plant would require approximately 118 employees, distributed as indicated below:

Plant manager and supervisory force	20
Office supervisory, accountant, clerks and stenographers	10
Skilled workmen	36
Semi-skilled workmen	20
Unskilled workmen	32
Total	118

Adequate skilled and ordinary labor to operate the plant are available in Rangoon. One qualified manager from abroad would be required to manage, operate and train local personnel during the first two years of operation.

(6) *Recommendations*

Wallboard, at present, has a small domestic market. Plywood, gypsum, and asbestos-cement sheets are used instead of wallboard. It is recommended that the construction of the proposed board plant be deferred until such time as a ready market for wallboard is definitely established. However, general plans for the proposed mill should be incorporated into the over-all program for an integrated forest products industry. It is estimated that two and one-half years would be required to design the plant, procure equipment, and build and put it into operation. The demand for the output of the plant should be anticipated by that length of time.

(e) Furniture factory. To balance the integrated forest products industry, it appears advisable to establish a small plant to manufacture furniture. Aside from the domestic furniture market there is a possible export market. In 1947, 1948, and 1949, K8,00,000 to K9,00,000 worth of furniture was exported. Such furniture was sold "knocked-down" to be assembled at destination. No exports have been made in recent years. Little wood furniture is imported, as it can be produced economically in Burma.

The plant should be built to supply the domestic market primarily, as an export market is not reliable. No statistics exist regarding the domestic market, but it is believed that Burma can absorb the output of the proposed plant. Most of the furniture now built in Burma is made by hand in small cabinet shops. There are no furniture plants in operation comparable to the one proposed for mass production with motorized woodworking machines. The products would include household, office, restaurant, store, hotel, public building, hospital and professional furniture. Using indigenous woods the plant would add to the integration of the wood products industry and help to expand the economy of Burma.

(1) The plant should be a separate building constructed adjacent to the joinery works. All of the advantages of locating the plant as an integrated part of the other phases of the wood processing program are equally applicable to the establishment of this plant. The recommended site is discussed in a project report on this subject. For location and layout see Plates 6 and 11.

The estimated cost of the furniture factory is as follows:

	K
Cost of equipment, delivered, Rangoon	6,70,000
Erection of plant	71,300
Equipment foundations	32,300
Buildings	5,80,000
Total costs	13,53,600
Land costs and site improvement 5%	64,400
Total	14,18,000

These estimates are based on United States equipment with buildings purchased from the sterling area. This will require approximately 7·0 lakhs of purchases in dollars and about 2·3 lakhs in sterling currency. The balance of 4·3 lakhs is in kyats. Dollar costs could be reduced somewhat by purchasing part of the equipment from the sterling area, if it is available from that source.

(2) *Production costs*

The estimated production costs of items of furniture have been based on an estimated number of pieces that could be produced under operating conditions prevailing in Rangoon. A complete list of personnel capable of manning all operations of the plant was set up to facilitate making this estimate. The output of the plant was estimated at approximately 70% of the equipment capacity. This conservative estimate of production is made for a period of the first year, to allow for the training of local personnel. These production costs are based on operating the plant one shift a day.

PRODUCTION COSTS

		K	K
Interest and amortization on buildings (20 yrs. at ·07358) 6·0 lakhs			44,000
Interest and amortization on equipment (15 yrs. at ·08994) 7·5 lakhs			67,500
Power costs 300,000 kWh at K0.20			60,000
carried forward			1,71,500
Material costs (Lumber)			
Teak	1,600 c.t. at K700	11,20,000	
Durable	1,600 c.t. at K450	7,20,000	
Semi-durables	800 c.t. at K375	3,00,000	
Plywood	600 m sq. ft. at K 349	2,29,400	
			23,69,400
Material imported			
Nails	100 cwt. at K50	5,000	
Metal fittings and hardware	200 cwt. at K70	14,000	
Glue	80,000 lbs. at K2	160,000	
Pretreatment	1,800 c.t. at K13	23,400	
Finish materials		1,100	
			2,03,500
General office expenses 300 days at K30			9,000
Workshop and stores 300 days at K50			15,000
Labor Costs			
Supervision		60,000	
Office		1,10,000	
Operations		2,15,000	
Miscellaneous		20,000	
			4,05,000
Plant maintenance 5% of K7,40,000			37,000
Operational contingency			2,12,600
Total			34,23,000

The annual production of the plant and its value based on an estimated export price of selected pieces of furniture that would be manufactured is as follows:

CURRENT SELLING PRICES

		K
9,000 Desks	K125	11,24,000
9,000 Cabinets	K225	20,25,000
7,500 Tables	K130	9,75,000
7,500 Chairs	K 45	3,37,500
Total Value		44,61,500
Total Operational Costs		34,23,000
Gross Annual Profit		10,38,500

(3) *Raw materials*

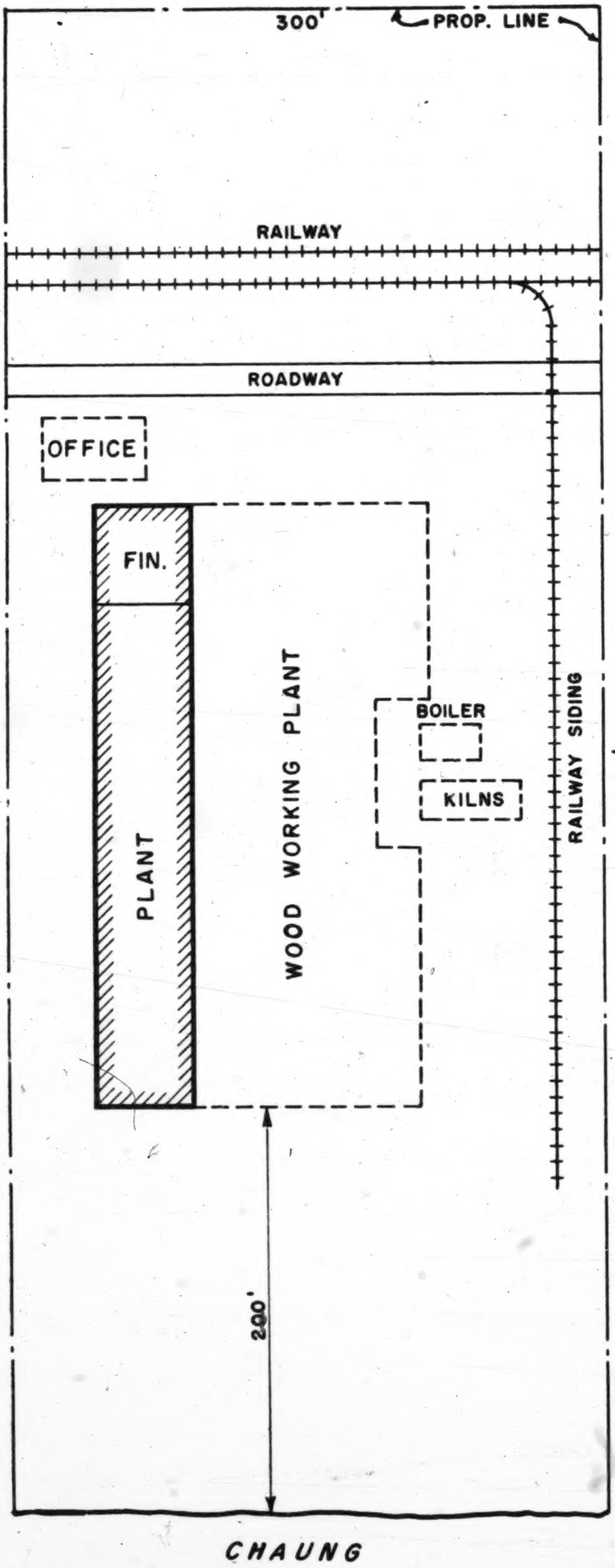
Converted lumber will be the chief raw material required for the manufacture of furniture. It is recommended that durable and semi-durable hardwoods be used insofar as possible. The semi-durable and non-durable woods can be chemically treated so that they can be utilized.

(4) *Employment*

Adequate skilled and unskilled labor is available in the Rangoon area. Capable personnel should be available locally to manage and supervise this plant. Approximately 120 employees are required to operate the plant, distributed as indicated below:

PERSONNEL

Management and superintendents	3
Supervisory	7
Skilled workmen	30
Office, shipping and stores	10
Unskilled workmen	70
	120


300'
PROP. LINE
RAILWAY
ROADWAY
OFFICE
FIN.
PLANT
WOOD WORKING PLANT
BOILER
KILNS
RAILWAY SIDING
750'
200'
CHAUNG

PLOT PLAN
SCALE 1" = 80'

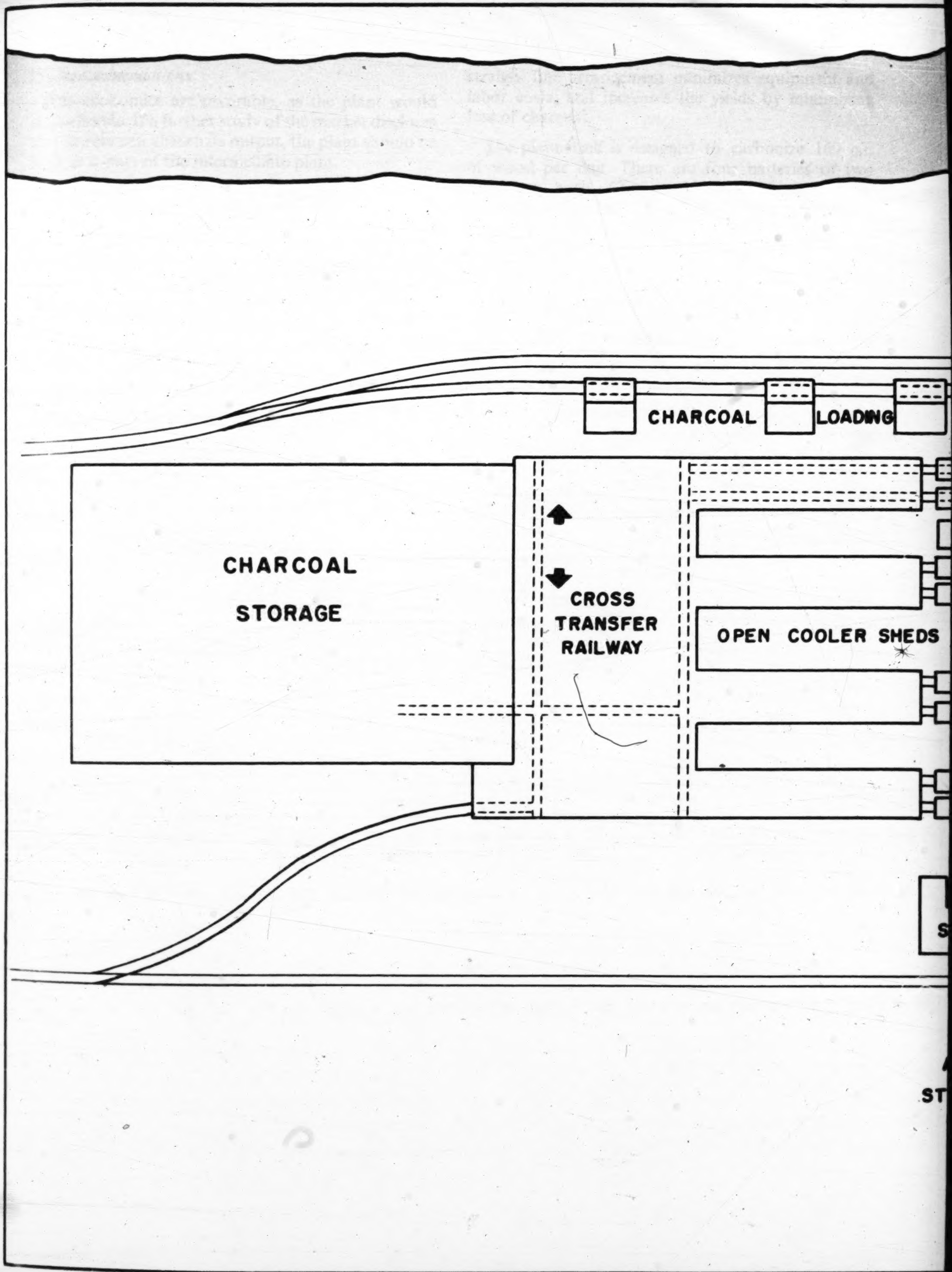
MINISTRY OF NATIONAL PLANNING

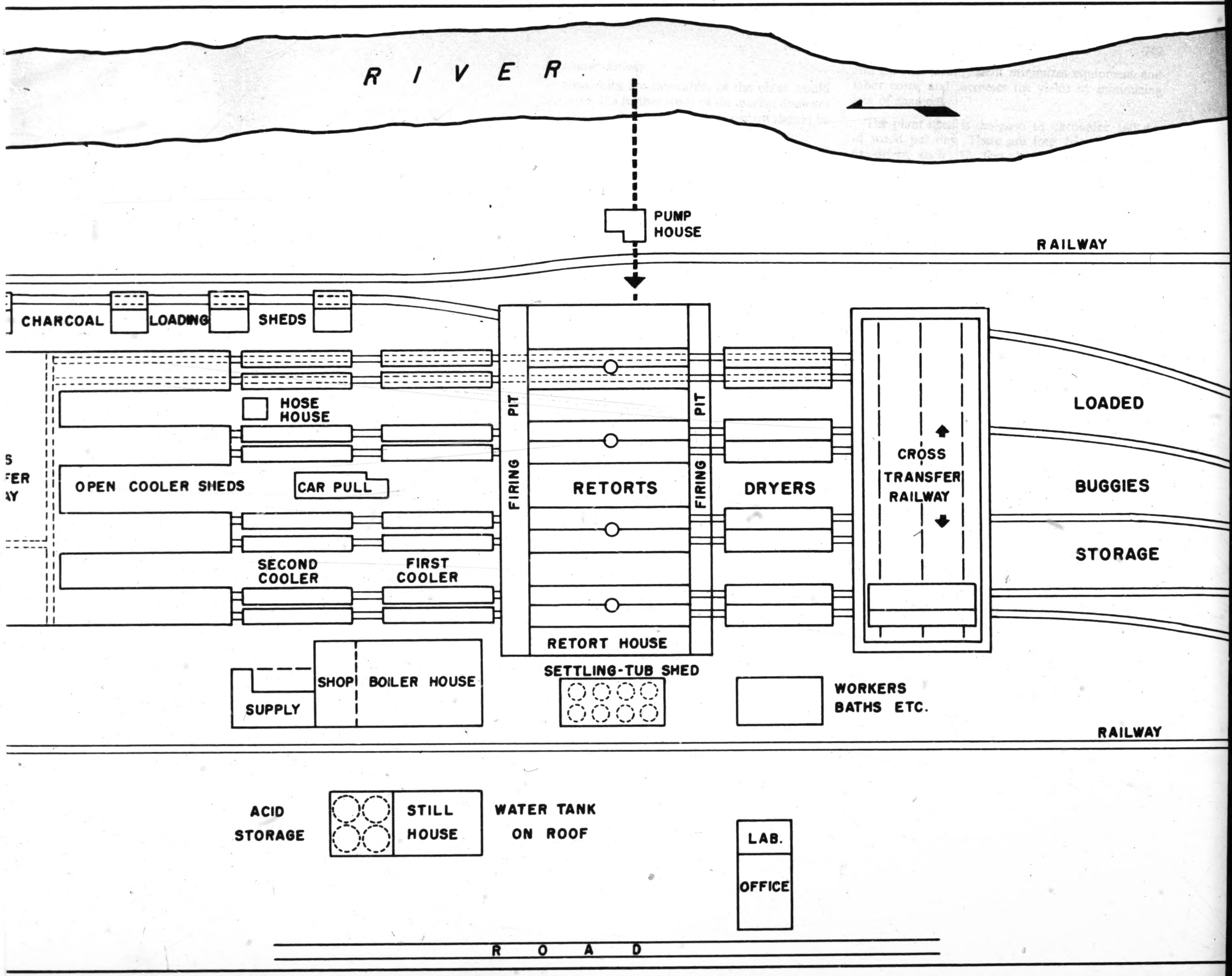
INDUSTRIES

FURNITURE PLANT

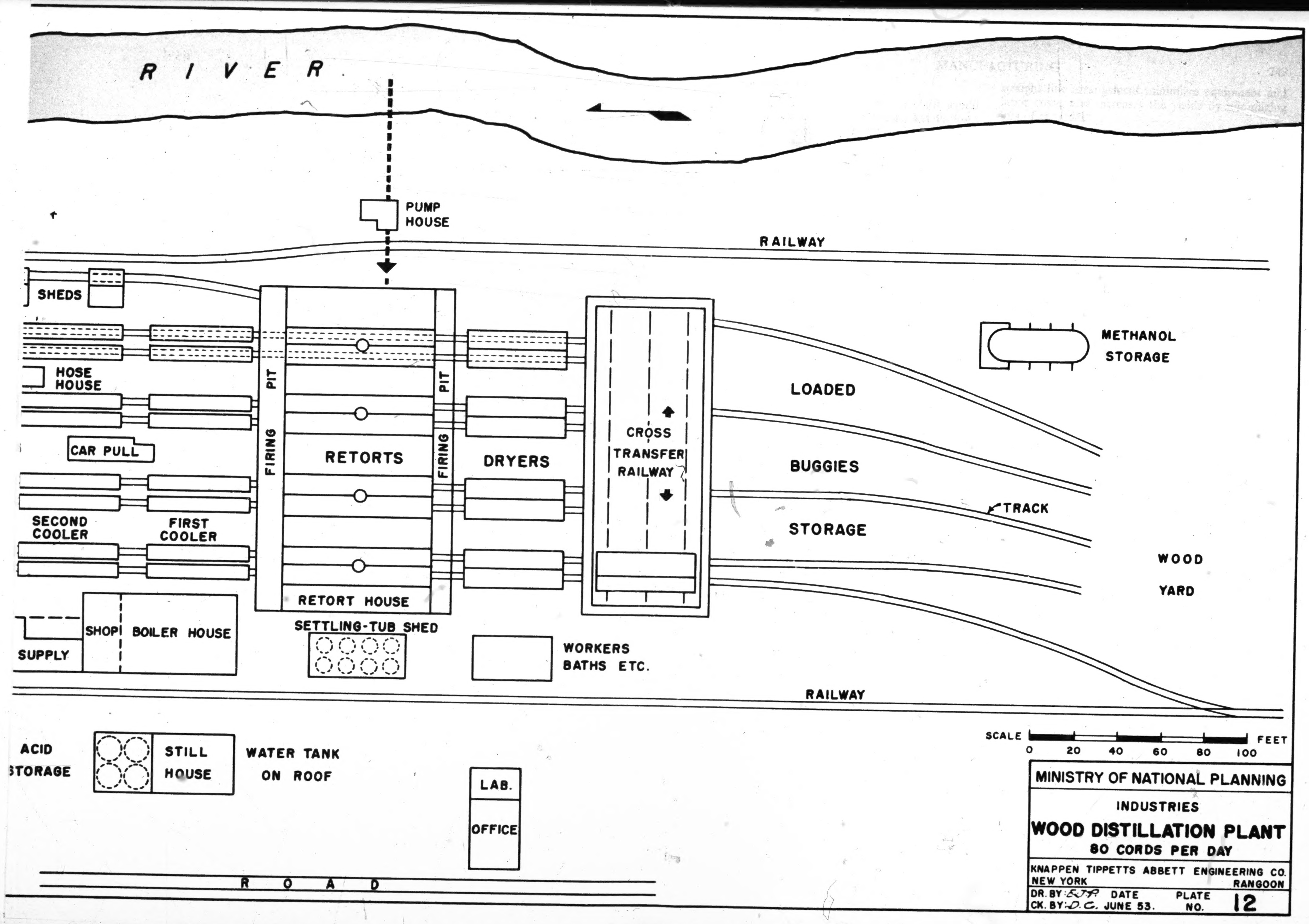
KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P. DATE PLATE
CK. BY D.E.C. JUNE 53 NO. 11


CHARCOAL
LOADING
CHARCOAL
STORAGE
CROSS
TRANSFER
RAILWAY
OPEN COOLER SHEDS
S
ST



RIVER
PUMP HOUSE
RAILWAY
CHARCOAL LOADING SHEDS
HOSE HOUSE
PIT
PIT
FIRING
FIRING
RETORTS
DRYERS
CROSS TRANSFER RAILWAY
LOADED
BUGGIES
STORAGE
S
FER
AY
OPEN COOLER SHEDS
CAR PULL
SECOND COOLER
FIRST COOLER
RETORT HOUSE
SETTLING-TUB SHED
SHOP
BOILER HOUSE
SUPPLY
WORKERS BATHS ETC.
RAILWAY
ACID STORAGE
STILL HOUSE
WATER TANK ON ROOF
LAB.
OFFICE
ROAD


RIVER
PUMP HOUSE
RAILWAY
SHEDS
HOSE HOUSE
CAR PULL
SECOND COOLER
FIRST COOLER
FIRING PIT
RETORTS
FIRING PIT
DRYERS
CROSS TRANSFER RAILWAY
RETORT HOUSE
METHANOL STORAGE
LOADED
BUGGIES
STORAGE
TRACK
WOOD
YARD
SUPPLY
SHOP
BOILER HOUSE
SETTLING-TUB SHED
WORKERS BATHS ETC.
RAILWAY
ACID STORAGE
STILL HOUSE
WATER TANK ON ROOF
LAB.
OFFICE
ROAD
SCALE
0
20
40
60
80
100
FEET

MINISTRY OF NATIONAL PLANNING

INDUSTRIES

WOOD DISTILLATION PLANT
80 CORDS PER DAY

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY: E.J.P. DATE
CK. BY: D.C. JUNE 53.
PLATE NO. 12

(5) *Recommendations*

The economics are favorable, as the plant would be profitable. If a further study of the market discloses that Burma can absorb its output, the plant should be built as a part of the intermediate plant.

(f) Wood distillation plant. Burma uses a large amount of charcoal for domestic and a minor amount for industrial purposes. In many smelting operations charcoal can be used as a substitute for coke. Present production of charcoal is largely by primitive methods and a considerable amount of valuable by-products is lost. These by-products include: acetic acid which is used in the manufacture of cellulose acetate and acetate plastics, acetic anhydride, ester solvent, metallic acetates, and various metal compounds such as calcium compounds, white lead, Paris green, acetamide, aspirin, and other pharmaceuticals, and artificial vinegars; methanol which is used in the manufacture of formaldehyde, denaturants, solvents and for other miscellaneous purposes; insoluble tars which have many domestic uses such as treatment of rope and fish nets; combustible wood gases that can be burned under the retorts or under the boilers to produce steam; and tannin extract from mangrove bark which has a domestic use in the tanning of leather and has a very wide world market (see plate 12).

As the demand for these industrial chemicals increases in Burma, or export markets can be developed, serious consideration should be given to the construction of a wood distillation plant.

(1) *The market*

The present demand for charcoal is being met by local carbonizing enterprises which do not attempt to save the by-products. Such chemicals as might be produced in a modern wood distillation plant are, at present, imported. It is expected that this market will increase within the next decade to justify producing these chemicals in Burma where an ample supply of raw materials is available.

(2) *The plant*

Jungle wood, the raw material, is piled in storage piles to dry some distance from the plant as a precaution against fire. The wood is cut into four-foot lengths for convenience in handling. For carbonizing, the wood is piled into 12-foot long buggies holding approximately five cubic tons each. Four buggies are coupled together as a unit for handling through the plant. The tracks (4 ft. 8½ in. gauge) are arranged to permit the loaded cars to pass through the plant to the charcoal storage shed in a straight line. This straight line arrangement minimizes equipment and labor costs, and increases the yields by minimizing loss of charcoal.

The plant itself is designed to carbonize 160 c.t. of wood per day. There are four batteries of two pre-driers, each 52 feet long by 8 feet high. Following these are the retorts in four batteries of two each, 52 feet long, 6 ft. 3 in. wide, by 8 ft. 4 in. high. First and second day coolers follow on the same trackage.

The retorts are housed in a steel retort house or shed approximately 160 ft. by 60 ft., having two firing tunnels running full length under the oven doors. There are 16 cooling chambers; four banks of two each for first coolers, and four banks of two each for second coolers.

Five days are required to process the wood. However, production is continuous and 160 cubic tons of wood are turned out daily. At least 200 buggies would be required to accommodate the several operations and to allow a reasonable number of spares.

The still house, located adjacent to the retort house, would be approximately 24 ft. by 40 ft. in floor area with a height of about 70 ft. There would be, besides the ground floor level, an operating floor level and a condenser floor level. A heavy steel frame would support a water tank on the roof. Sidewalls would probably not be necessary. This structure would accommodate the recovery of the liquor from the retorts after settling in outdoor settling tanks for tar removal, and there would be a de-methanolizing system, an ageotropic recovery system for the acetic acid, refining systems for the methanol and the acetic acid.

A storage shed is necessary for the acetic acid tanks. The methanol will be stored in large tanks in the open. A pump house for cooling water from the river, a large charcoal storage building with suitable facilities for bagging, a machine shop about 24 ft. by 48 ft., and an office and a small laboratory for chemical control complete the plant.

(3) *Estimated cost of the plant*

The following is an estimate of costs of the proposed plant erected in Burma for the installation of 160 c.t. (round log) of mangrove or similar wood per day. This estimate includes the cost of the installed plant ready for operation including all equipment, buildings, boiler house, a small electric generator, plant water supply, railroad trackage for wood yard, and necessary storage capacities.

	K
Cost of equipment, delivered, Rangoon	45,50,000
Erection of plant	11,87,500
Equipment foundations	38,000
Buildings	14,82,000
Miscellaneous trackage—tanks boilers	1,42,500
Total costs	74,00,000
Land costs and site improvements 5%	3,70,000
Total	77,70,000

The estimate is based on United States equipment and on buildings purchased in the sterling market. The expenditures will require approximately K48 lakhs of purchases in dollars and about K15 lakhs in sterling currency. The balance of K11 lakhs is in kyats.

(4) *Cost of production*

The three principal products are charcoal, acetic acid and methanol. Charcoal is the largest (by volume) single product that will be produced from this wood distillation plant and it is recommended that this be produced so that in the future, commercial use be made of this produce in industry as a substitute for coke. Acetic acid has many uses as mentioned earlier in this Report. Methanol has a wide use and markets for this product should be readily available in Burma.

PRODUCTION COSTS
Based on 160 c.t. Capacity Plant

	K
Interest and amortization based on 20 yrs. at ·07358	5,60,000
Maintenance and repairs	1,92,000
Workshop and stores	1,29,600
Electrical power	1,44,000
Fuel (for carbonization)	2,59,200
Management and supervisory	1,53,600
Operational labor	1,39,200
Wood raw materials	3,36,000
Totai annual operational costs	19,13,600

The estimated annual production of the plant and its value based on imported prices for these products, are as follows:

		K
Methanol	600 tons at K1,200	7,20,000
Acetone	48 tons at K1,800	86,400
Acetic Acid	1,440 tons at K2,100	30,24,000
Charcoal	7,500 tons at K 70	5,25,000
Total annual revenue		43,55,400
Total annual operational costs		19,13,600
Gross annual profit		24,41,800

The above production figures are based on 2,000 lbs. per ton and the unit costs in kyats c.i.f. Rangoon.

(5) *Raw materials*

The raw material required for the operation of the plant could be any one of the "jungle" or non-durable woods. However, mangrove will be the most profitable in conjunction with another plant that would utilize the bark for tannin as a paste or powder. It is estimated that a plant of 160 c.t. a day capacity under maximum production will require 48,000 c.t. of round logs annually. The estimated cost of these logs delivered to the plant is K7 per c.t.

(6) *Personnel requirements*

The operation of this plant will require approximately 187 employees, distributed as follows:

Wood Distillation Plant Personnel

Plant manager and supervisory force	7
Office supervisory, accountants, clerks, etc.	20
Supervisory	10
Skilled workmen	65
Unskilled workmen	85
	187

Adequate skilled and unskilled labor is available in the Rangoon area. A plant manager from abroad would be required to manage the plant during the first two years of operation during which time local personnel would be trained in its operation.

(7) *Recommendations*

It is recommended that the general plans for this proposed mill should be incorporated into the over-all program for Burma's industrialization. The engineering should be done in the United States where large wood distillation plants are in operation and where modern processes have been developed. Much of the equipment, particularly the heavy steel fabrications, could be obtained in the sterling area.

Approximately two years and six months will be required to design, build and put the plant into operation. It is estimated that markets will develop to use the output of chemicals by 1959 if the industrial program proceeds as scheduled. It would therefore be necessary to start design of the plant in 1956.

The location recommended for the plant is in the Bassein or Moulmein area where adequate supplies of mangrove wood are available.

(g) Tannin and cutch extraction plant

(1) *The market*

The domestic market for tannin is limited and is confined to the leather tanning industry which has not been fully developed. There is a moderate world market, the United States alone having imported 168,000 metric tons in 1951. The principal use of tannin is for tanning leather. Minor uses include the manufacture of pharmaceuticals and others. Cutch is used for the preservation of fishing lines and in salt water nets, and to a limited extent in the manufacture of dyes. Prior to World War II approximately 3,500 tons were exported annually. The domestic consumption for the same period is estimated at about 5,000 tons per year.

(2) *The plant*

A plant for the extraction of both tannin and cutch should be considered for the ultimate development of the integrated forest industries. The plant would consist of a one-story steel building, 50 ft. by 170 ft. in area, and a covered storage area about 50 ft. by 100 ft. A small office building would also be required. The equipment would consist of the following:

2 Bark cutting machines
2 Vibrating screens
2 Hammer mills
1 Collecting worm
1 Clesstor
1 Distributing worm
7 Feeding hoppers
7 Extractors
7 Calorizers
1 Pre-heater
3 Duplex steam pump
Copper piping
1 Collecting container
2 Clarifying wood vats
1 Mud fitter vat
1 Collecting wood vat
5 Vacuum evaporators
3 Centrifugal pumps
1 Water supply pump
1 W.I. container for cold water
1 Steam boiler plant
1–3 Plunger pump
1 Steam engine
1 Electric generator for cutch extraction
1 Chipper for chipping cutch heartwood
Necessary conveying equipment

The estimated cost of the plant erected in Burma is as follows:

	K
Cost of equipment, f.o.b., Europe	8,50,000
Cost of packing, freight, insurance, etc.	1,05,000
Erection of equipment	3,75,000
Equipment foundations	75,000
Buildings and storage areas	4,15,000
Miscellaneous items and contingencies	1,80,000
Total Costs	20,00,000
Land and site improvements 5%	1,00,000
Total	21,00,000

The estimate is based on proposals and recommendations received from European equipment manufacturers and assumes that all equipment and most of the buildings, of light steel frame construction, will be purchased in sterling exchange. The installation of the equipment and construction of the plant can be in kyats. The expenditure will require approximately K13,00,000 in sterling exchange and the balance about K7,00,000 in local currency.

(3) *Cost of production*

The cost of production is based on the extraction of tannin only and the sale of this produce on the world market. Although the plant will be designed so that cutch can be extracted, this market is not well defined at this time. It is assumed that the cost of production for cutch can be made competitive in the world market. Cost of production based on 1,800 tons per year are:

	K
Interest and Amortization based on 20 years at ·07358	1,47,200
Maintenance and Repairs (30·00 c.t. × 6,000 t)	1,80,000
Workshop and Stores (K20 c.t × 6,000 t)	1,20,000
Electrical Power 650,000 kWh at K0.20	1,30,000
Fuel for boilers (K50 c.t. × 6,000 t)	3,00,000
Management and Supervisory K20 (c.t. × 6,000)	1,20,000
Operational Labor (K25 c.t. × 6,000 t)	1,50,000
Raw Materials (20t/day × 300 days = 6,000 t at K200)	12,00,000
Packaging 1,800 t at K25	45,000
Exporting costs 1,800 t at K2.00	3,60,000
Total Annual Production Costs	27,52,200

The estimated annual production of tannin extract and its value based on prices on the world market are as follows:

Tannin Extract 1,800 t at K2,000	36,00,000
Total Annual Production Costs	27,52,200
Gross Annual Profit	K 8,47,800

(4) *Raw materials*

Ample raw materials are available in Burma; for tannin, the bark of trees from the coastal swamps, and cutch from the dry forests. Both have been exploited in the past on a small scale. Mangrove bark is now sold in Rangoon for approximately K180 per ton. It is harvested as a by-product of jungle wood which is sold for fuel.

(5) *Employment*

The harvesting of mangrove and cutch will create part-time employment in the coastal and hill villages.

The operation of the plant will require approximately 113 employees, as indicated below:

Personnel	
Plant manager and supervisory force	18
Office supervisory, accountants, clerks, stenographers	12
Skilled workmen	30
Semi-skilled workmen	18
Unskilled workmen	35
Total	113

Adequate skilled and unskilled labor to operate the plant is available. One qualified manager from abroad would be required to manage, operate and train local personnel during the first two years of operation.

(6) *Recommendations*

It is recommended that the general plans for this project be incorporated into the over-all program for an integrated forest products industry. The scheduling of implementation can be coordinated with other recommended industries that are to be deferred for future consideration.

(20) Paint and Varnish Factory

(a) The market. The current volume of paint and related products used in Burma is approximately 400,000 gallons annually. Most of these products are imported. The requirements for paints can be expected to increase materially with the implementation of the development program. The existing and future demand provide an ample market to justify the implementation of a paint and varnish industry.

(b) The plant. The plant should be designed for a capacity of 10,000 gallons per week, of paint, varnish, lacquer and rubber latex. It should be located in Rangoon since that will be the largest market and is the most advantageous location for procurement of raw materials and the distribution of the finished products.

The plant will consist of a single building with a floor area of 8,000 sq. ft. on the ground and 2,500 sq. ft. each on a first and second floor. The equipment proposed is sufficiently flexible to accommodate major variation in demand, as to type of products and output (see Plate 13).

The estimated cost is as follows :

	K
Equipment delivered Rangoon	12,85,000
Installation of Equipment	3,00,000
Buildings	4,74,000
Equipment Foundations	33,750
Contingency	1,00,250
Total costs	21,93,000
Land Costs and Site Improvement 5%	1,10,000
Total	23,03,000

Equipment costs are based on comparable equipment for similar plants in the United States. The necessary construction materials that must be imported can be obtained in the sterling area. The expenditures required for this plant will be approximately K13,00,000 for equipment to be purchased with dollar exchange and about K3,00,000 in sterling currency. The balance of K6,00,000 is in local currency. Dollar costs can be reduced somewhat by purchasing part of the equipment from the sterling area.

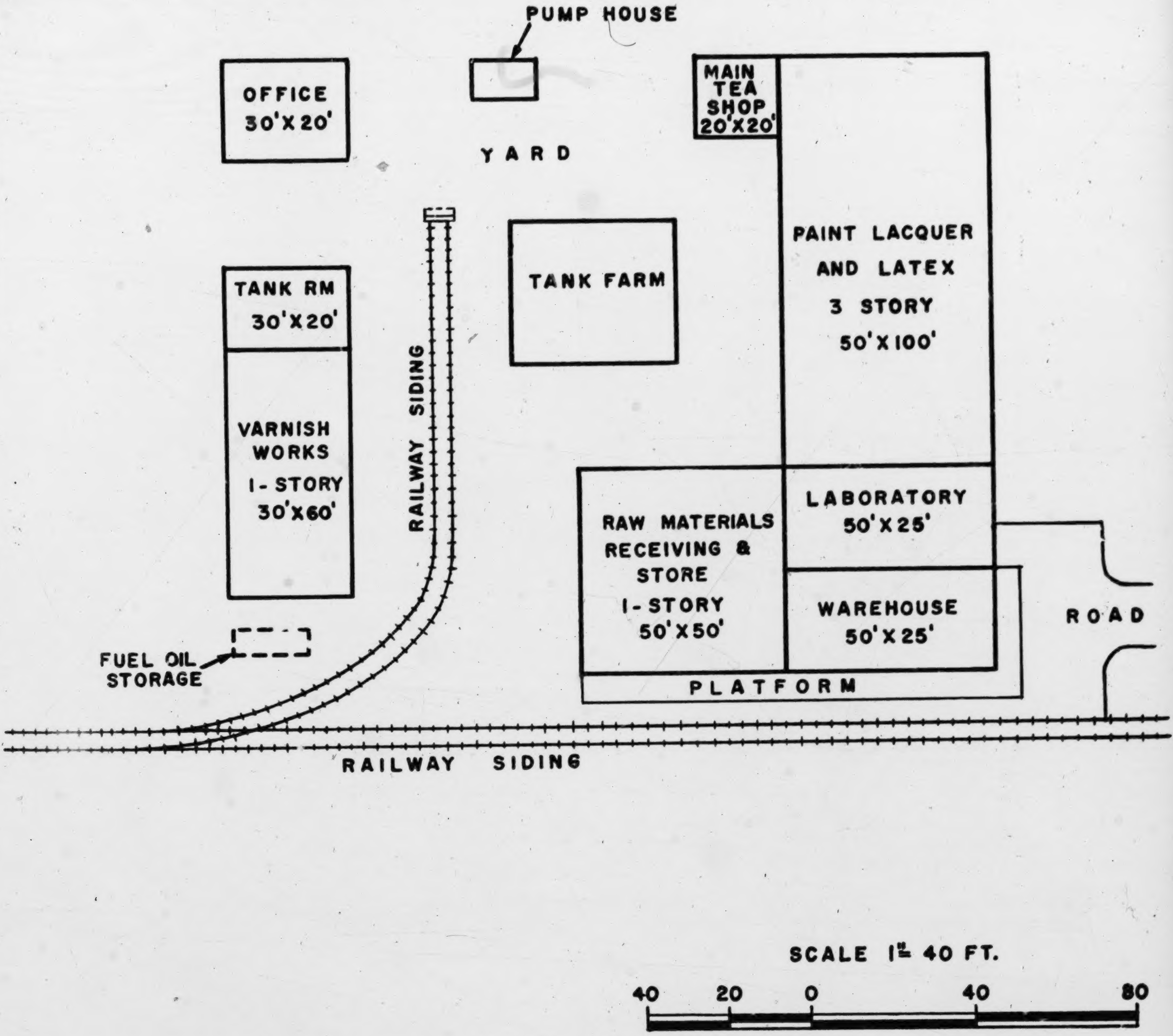
(c) Cost of production. Formulations for the various products differ considerably, the number of constitutents varying from one or two to as many as twenty. Therefore, the raw materials and manufacturing cost of individual products will differ considerably.

For purposes of setting up an estimated production cost, several typical latex formulations have been investigated and one is set forth as an example. A careful study of each individual product must be made before a final sales price is set. The raw materials cost of this formulation has been used as an average cost in the estimate, although some prices will of course be higher and others considerably less.

Present day latex manufacturers produce paints with from 2·8 to 3·5 lbs. pigment mix per gallon of paint. Therefore, it has been assumed that for all paint produced, in any color, the average of 3·25 lb./gal. pigment mix was used.

Any estimate of the relative quantity of each color sold in any one year is at best a hazarded guess, since human tastes and whims have much to do with the color chosen. However, six basic colors were chosen and an estimate of the raw materials costs per gallon was made and the average of these six is used as a basis for analysis. The following production costs are based on the operation of this plant on a 43-week annual operating schedule.

	K
Interest and Amortization (20 year basis at ·07358)	1,62,000
Raw Materials at K7.32/gal.	31,47,600
Packaging Costs at K0.62/gal.	2,66,600
Steam Costs at K0.02/gal.	8,600
Electricity at K0.05/gal.	21,500
Water at K0·005/gal.	2,200
Maintenance at K0.14/gal.	60,200
Laboratory at K0.11/gal.	47,300
Misc. Supplies at K0.03/gal.	13,000
General Office Supplies at K0.10/gal.	43,000
Labor at K0.70/gal.	3,02,000
Supervisory at K0.10/gal.	43,000
Marketing Exp. at K0.60/gal.	2,58,000
Contingency	4,25,000
Total Manufacturing Costs	48,00,000


PUMP HOUSE
OFFICE 30'X20'
YARD
MAIN TEA SHOP 20'X20'
PAINT LACQUER AND LATEX 3 STORY 50'X100'
TANK RM 30'X20'
TANK FARM
VARNISH WORKS 1-STORY 30'X60'
RAILWAY SIDING
RAW MATERIALS RECEIVING & STORE 1-STORY 50'X50'
LABORATORY 50'X25'
WAREHOUSE 50'X25'
ROAD
FUEL OIL STORAGE
PLATFORM
RAILWAY SIDING
SCALE 1"= 40 FT.
40
20
0
40
80

MINISTRY OF NATIONAL PLANNING.

PLANT LAYOUT
10,000 GALLONS PER WEEK
PAINT, VARNISH, LACQUER AND LATEX.

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK. RANGOON.

DR. BY. EJP DATE PLATE
CK. BY. DEC JULY 53. NO. 13

These production costs are based on the manufacture of one kind of paint and it is assumed that other types can be produced with corresponding margins of profit.

Using a conservative selling price in Burma of K14 a gallon (which may be compared to the same paint in the United States selling for approximately $3.50 (K16.63) a gallon), the nearest comparable paint now imported into Burma sells for about K16 c.i.f. per gallon.

Annual Revenue 430,000 gal. at K14.00	K60,20,000
Annual Manufacturing Costs	K48,00,000
Gross Annual Profit	K12,20,000

(d) Raw materials. Most of the raw materials are found in Burma with the exception of linseed oil. It is understood that 30,000 acres of land along the Sittang and Irrawaddy Rivers are suitable and available for the cultivation of flax as second crop after paddy. Turpentine, resins and lac are found in Burma and are collected and extracted to some extent on a cottage industry scale. The methods used for collection and extraction have not been profitable. Steps are now being taken in the Shan States to increase the quantity and the efficiency of the extraction and collection of turpentine, resins and lac. The estimate of manufacturing costs was based on imported raw materials because no established prices of indigenous materials were available. The development and expansion of the mineral and chemical resources of Burma will provide raw materials for the implementation of a paint manufacturing plant.

(e) Employment. The project would create employment at the plant as indicated below and indirectly in the procurement of raw materials needed for the products manufactured.

Plant Manufacture Personnel

Plant Manager and Supervisory Force	8
Office Supervisory, Accountants, Clerks, etc.	22
Supervisory	14
Skilled Workmen	72
Unskilled	70
	186

Adequate skilled and unskilled labor is available in the Rangoon area. A plant manager from abroad would be required to manage and operate the plant during the first two years of operation during which time local personnel would be in training to take over.

(f) Recommendations. General plans for this proposed paint manufacturing plant should be included in the program for industrial development of Burma. The project could be developed as a government enterprise, a joint venture, or a private enterprise. It is recommended that its implementation be deferred until the more essential industrial projects are implemented, unless it is undertaken as a private venture which would not impose this additional load on governmental implementing agencies.

(21) Rubber and Rubber Products

(a) The market. The incongruity of the Burma rubber market is the peculiar proportion between the value and volume of rubber goods imported and indigenous raw rubber produced. The value of rubber goods imported is about the same as the value of the

TABLE XXII – 15

RUBBER IMPORTS, VALUE AND ESTIMATED WEIGHT, 1951–52

Commodity	*Total Value*	*Total Quantity*	*Average Value per unit*	*Estimated Weight of Rubber only, per unit*	*Estimated Weight of Rubber only, Total*	*Weight percentage of Total, all Commodities*
	Kyats	*Number*	*Kyats*	*Pounds*	*Pounds*	
Rubber Soled Footwear with Canvas Uppers	1,80,264	39,827 pr.	4.52	0·5	19,913	1·4
All-Rubber Footwear, No Canvas	49,799	9,359 pr.	5.31	1·5	14,038	1·0
Pneumatic Rubber Tires for Autos	1,50,54,118	74,274	202.68	12	891,288	62·9
Pneumatic Rubber Tubes for Autos	15,67,018	64,929	24.13	3	194,787	13·5
Pneumatic Rubber Tires for Bicycles	12,30,894	198,645	6.19	1	198,645	13·9
Pneumatic Rubber Tubes for Bicycles	4,31,073	180,895	2.38	0·25	45,223	3·2
Solid Rubber Tires for Motor Vehicles	18,705	1,283	14.57	6	7,698	0·5
Other Rubber Manufactures	15,86,050	—	—	@ K30 to 1 lb.	52,800	3·6
Total	2,01,17,901	—	14.10	—	1,424,392	100

raw rubber produced in Burma, but the quantity of pure rubber in the imports is equal to only 5% of the quantity of the raw rubber indigenously produced. The remaining 95% of the value goes to foreign countries for profit, service, labor, and other materials which consist mainly of cotton cord and binder materials.

At the present time, Burma imports over K2,00,00,000 of rubber goods a year.* A total of 94% of these imports are rubber tires and tubes. There are tire plants located in almost every country. The consumption of rubber by vehicular transport dwarfs every other requirement for rubber. For the year 1951–52, Burma imports of tires and tubes alone amounted to K1,83,01,808. The only remaining item of single importance is rubber footwear in which the rubber content amounted to only 2·4% of total rubber imports. Table XXII–15 (*p.* 754) gives a classified list of the total rubber-goods imports for the year 1951–52.

The various types of rubber products are extremely diversified. Next to pneumatic rubber tires and tubes in volume of consumption for industrialized countries is the rapidly expanding field of rubber conveyor and power transmission belting. Burma's present industrial requirements are limited but this may be expected to increase in the next 15 years. A listing of the most common rubber products in the order of their general volume of consumption is :

Tires and tubes for automobiles, buses, trucks, motorcycles, bicycles, tractors
Rubber soled canvas shoes
All-rubber shoes, boots, galoshes
Rubber slippers, sandals
Rubber heels, soles
Rubber hose, industrial and domestic
Rubber mats
Rubber belting, conveyor and power transmission
Rubber cushions, pillows, mattresses, upholstery
Solid rubber blocks for rice mills
Rubber raincoats, waterproof clothing
Rubber sports goods, golf balls, tennis balls, rubber balls, padding, clothing, tents
Surgical manufactures of rubber
Rubber balloons
Rubber toys, animals, dolls
Rubber bands
Rubber swimming tubes
Rubber molded industrial products
Auto battery cases
Fountain pens, hard rubber products
Rubber insulated wires and cables.

The proportion of pure rubber utilized in forming many of these products is deceptively small. In many cases the bulk of the article is formed of cotton cord, bead wire, accelerator and stabilizing chemicals. The average automobile tire has an actual rubber content of only 54%. The automobile tire is ordinarily composed of three types of rubber : natural rubber, synthetic rubber, and reclaimed rubber, which are mixed together. Natural rubber tends to lend toughness, elasticity and wearing quality to the tire. Synthetic rubber imparts an ability to withstand higher road temperatures, but it is also often less costly and easier to obtain than natural rubber. Reclaimed rubber is used because of its low cost and also because it completes the rubber blend more satisfactorily than chemicals or any other one type of rubber. The ratio of synthetic and reclaimed rubber is not rigidly static and natural rubber can replace them to a great extent. The general specification weights of passenger car and truck tires are as follows (see Table XXII–16).

TABLE XXII – 16

COMPOSITION SPECIFICATION OF AUTOMOBILE AND TRUCK TIRES

Material	*Specification Weights*					
	Average Passenger Car Sizes: 6·00–16, 6·50–16, 6·70–15, 7·10–15, 7·60–15			*Average Truck Sizes: 6·00–16, 6·50–16, 7·50 × 20–10, 8·25 × 20–10, 10·00 × 20–12*		
			lbs.			lbs.
Natural Rubber	53·8% (12·28 lbs.)	9·1%	2·08	47·6% (30·1 lbs.)	26·9%	17·0
Synthetic Rubber		35·0%	8·0		17·8%	11·3
Reclaimed Rubber		9·7%	2·2		2·9%	1·8
Green Cotton Sugar Woven			0·12			0·86
Green Rayon			2·9			9·7
Bead Wire			0·64			2·3
Chemicals			7·5			18·3
Total Materials Weight			23·44			61·26
Deduct Shrinkage and Trim			—·56			—1·90
Net Tire Weight			22·88			59·36
Flap			—			4·10
Total Weight			22·88			63·46

The recommendation that consideration be given to construction of facilities for the manufacture of automobile tires does not stem from the quantity of rubber to be utilized by their production. The weight volume of pure rubber for an annual production of 50,000 automobile tires would be about 500,000 lbs., or 1·6% of Burma's 1952–53 production of rubber

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* K2,01,17,901 rubber-goods imports for 1951–52.

(31,322,500 lbs.). The basic reason for production consideration is the large sum represented by the import of these finished articles. If the tire is manufactured in Burma, the greater part of its labor and production cost will remain in the country. The following table shows the necessity of limiting the totals of rubber-goods imports which have been steadily increasing in volume and ratio until their total value has exceeded that of the export of all raw rubber for the years of 1946 to the present.

(b) Possibility of domestic production

(1) *Input materials and utilities*

Of raw rubber there is naturally an abundance. The input materials that are not presently produced in Burma are cotton and rayon fabric used in tires, rubber footwear, rubber ply hose, and industrial rubber belting. Other imported basic materials are chemicals such as carbon black, caustic soda, lithopone, sulphur and zinc oxide.

The utilities consumed consist of a modest amount of electrical power for the operation of mixers, grinders and presses. Coal is used to produce steam for the necessary vulcanizing and heating of rubber for molding and extruding operations.

(2) *Justification*

The production of automobile tires in Burma will tend to contribute directly toward the improvement of transport which is a basic condition toward the trade and welfare of villagers and rural people alike. A large portion of outgoing expenditure for the purchase of rubber imports will be eliminated with facilities for the indigenous production of rubber in Burma. If the amount of vehicular transport and service is increased through both the availability and economy of local tire production, then the economic level of the entire country will benefit. The resulting increase in direct and indirect employment produces a decided effect toward improved per capita output. The degree of skill for the majority of employees in a rubber plant is not great and there is no large number of skilled specialists who must be imported from other countries.

(c) Economic feasibility

(1) *Description and cost of plant*

In reference to rubber import table XXII–15, it is noted that the import of automobile tires is 74,274 for 1951–52. With approximately 28,000 motor vehicles listed for 1953, a tire plant with a production of approximately 50,000 automobile tires per year is recommended. The total cost of this plant is estimated at K62,40,000 as follows:

K40,00,000	Machinery and equipment for the production of 50,000 auto tires per year.
K10,00,000	Estimated installation cost of equipment.
K4,00,000	Transportation of machinery and equipment to Rangoon.
K6,00,000	Cost of all buildings.
K2,40,000	Engineering service including design, purchase, installation, and initial operation of entire plant.
K62,40,000	Total cost installed at Rangoon.

(2) *Production cost*

The production cost for automobile tires is estimated as follows, for both passenger and truck tires:

TIRE MANUFACTURING COST

Operation	*Average Passenger Sizes : 6·00–16, 6·50–16, 6·70–15, 7·10–15, 7·60–15 (All 4 ply)*	*Average Truck Sizes : 6·00–16, 6·50–16, 7·50 × 20–10, 8·25 × 20–10, 10·00 × 20–12 (All standard ply)*
	K	*K*
Material, including Rubber, Cord, Chemicals	27.70	83.80
Flap	—	5.08
Total Material	27.70	88.88
Direct Labor	2.94	9.60
Indirect Labor	0.76	1.99
Factory Burden	5.93	17.25
Curing	0.52	1.48
Waste Loss	0.57	2.23
Seconds Loss	0.29	0.67
Receiving and Handling	0.48	1.05
Wrapping	—	—
Total Direct Cost	11.49	34.27
Total Factory Cost	39.19	123.15
Warehouse, Shipping and Administration	2.75	8.08
Total	41.94	131.23

The current retail selling price of automobile tires in Rangoon is as tabulated on the following page.

Of secondary importance, next to the manufacture of automobile tires, is the production of camelback or tire recapping strips. Provision for the production of camelback would be included as a part of the tire plant. This will provide facilities for the production of 20,000 strips per year of automobile tire camelback.

(d) Recommendation. It is recommended that steps be taken by Government to implement the building of a factory for the manufacture of motor car, truck, and bicycle tires of selected sizes in most common use in Burma. The factory should also provide for the manufacture of camelback for tire recapping. It is

AUTOMOBILE TIRE PRICES

Passenger Car

Stock Sizes	*Tires*		*Tubes*
	6 ply	*4 ply*	
	K	*K*	*K*
Passenger			
5·50–15	117.75	91.50	13.00
6·00–15	125.25	96.50	14.00
6·50–15	152.50	117.50	17.25
4·50/4·75–16	—	69.50	13.00
5·00–16	99.25	79.25	13.75
5·25–16	104.75	83.75	13.75
5·50–16	123.75	94.75	13.75
5·75–16	124.50	96.00	13.75
6·00–16	126.25	97.50	14.25
6·00–16 (Jeep Type)	139.50	—	14.25
6·25/6·50–16	156.00	120.00	15.50
7·00–16	181.00	—	15.50
4·50–17	92.00	73.50	14.00
5·25/5·50–18	126.00	—	14.00
Super Balloon			
5·90–13	108.00	82.50	13.00
6·40–13	123.00	94.00	13.00
6·70–15	138.25	106.75	17.25
7·10–15	153.75	—	17.25
7·60–15	167.75	—	17.25
6·70–16	133.75	—	15.50
7·60–16	171.75	—	15.50

Note.—White sidewall single and double available in all 15-inch and 16-inch passenger car tires. Single 20% and double 25% above black sidewall tires.

TRUCK AND BUS TIRE PRICES

Stock Sizes	*Tires*			*Tubes*
	No. Ply	*BS/TPT*	*AT/HT*	
		K	*K*	*K*
Truck and Bus				
6·00–16 Delivery	6	139.50		14.25
6·50–16 ,,	6			
9·00–16	10	414.25		34.75
10·50/11·00–16	12	592.00		39.25
7·00–17	8	227.00		22.00
7·00–20/32×6	10	283.50	297.80	23.00
7·50–20/34×7	10	342.25	359.25	29.25
7·50–20/34×7	12	376.50		29.25
8·25–20	10	377.50		39.75
8·25–20	12	415.00		39.75
9·00–20	10	467.00		39.75
9·00–20	12	513.50		39.75
10·00–20	12	621.50		45.50
11·00–20	12	709.00		53.50

further recommended that the project be included in the intermediate plan to be started between 1956 and 1958. Before deciding on the specific capacity of the plant a careful study of the market should be made for sizes of tires and the feasibility of export.

(22) Clay and Shale Products

Except for a limited number of crude clay building-brick kilns, and a number of pottery plants of cottage industry size, there is no real clay products or ceramics industry in Burma.

Even in the important Rangoon area, where a greater number of higher type buildings exist than in any other city in Burma, there are no modern brick plants. Almost all building-bricks are manufactured in crude kilns owned and operated by the principal building contractors. The quality, size and shapes are uncertain and uneven.

(a) Tile. Clay roofing tile is not manufactured in the country although this type of roofing is commonly used on most permanent and semi-permanent building. It is all imported. Yet clays suitable for the manufacture of clay products are generally found in abundance in most countries, and particularly in alluvial delta areas, and are known to exist in abundance in Burma.

The imports of clay tile and brick into Burma have been recorded as follows:

Years	*Number* *	*Declared Import Value in Kyats*
Prewar		
1938–39	1,872,082	1,47,642
1939–40	2,441,804	1,88,853
1940–41	2,924,466	2,30,099
Prewar Average	2,412,784	—
1941–46	No records	
Postwar		
1946–47	1,573,269	3,30,906
1947–48	734,725	1,88,988
1948–49	1,977,518	5,70,867
1949–50	820,618	2,23,273
1950–51	635,451	2,17,878
1951–52	2,595,638	10,22,830
Postwar Average	1,389,369	

* Includes roofing tile, wall tile, and non-fire brick. Roofing tile made up 90% of declared value of 1951–52 imports.

The Government of the Union of Burma is implementing a large-scale housing program. It is estimated that approximately 240,000 new houses of the non-basha type will be built in the next ten years. It is also estimated that each of these will require an average of 2,000 sq. ft. of roofing. As other types of roofing will be used on many of these, all cannot be considered potential outlets for the sale of clay roofing tile. Assuming one fourth use clay roofing tile, a total of 120,000,000 sq. ft. of laid tile will be required. Each tile covers 0·90 sq. ft., thus a total of 133,333,000 roofing tile will be required, or an average of 13,333,000 per year, for this purpose alone.

In addition, large public and private buildings will increase this quantity. In general, it has been estimated that all construction material requirements will be 344% of the prewar requirements by 1959–60. On this basis the use of roofing tile should increase to 8,300,000 pieces per year by that date.

While these estimates do not check with each other, the latter figure is believed to be conservative, and the first one possible. Certainly if these tile were to be made in Burma, where they could be manufactured and sold cheaper than the imported product, their use would increase.

(b) Building-brick. No statistics are available regarding the use of common clay building-brick in Burma. However, statistics of brick manufactured in some other countries indicate an average annual use of 20 brick per capita. As Burma is ranked very low in comparison to the international average use of other basic building materials, the average use per capita for Burma would probably not exceed 25% of the international figure. Thus, on the basis of a per capita use of five brick per year, the estimated total use in Burma would be 93,720,000 brick per year.

The new housing program will require a tremendous number of building-brick. The rebuilding of the Pagoda at Pegu alone will require millions of brick; and many of the projected factory buildings for the development program will require millions more. The estimates previously made are therefore believed to be conservative.

Common clay building-brick, because they can normally be manufactured everywhere, cannot usually be shipped far. Thus no single brick plant can hope to supply all of Burma. It is not believed that more than 50% of the brick used will be sold in the Rangoon area. This would reduce the Rangoon market to about 45,000,000 per year. As there are a number of local brick plants, no single plant, however modern, would expect to make and sell more than 30–40% of the brick required in this market, or 18,000,000 per year.

(c) Government clay products plant. The Government of the Union of Burma has recognized the necessity for a modern clay products plant in the Rangoon area, and has purchased the machinery and equipment for this purpose. This plant will have the capacity to produce 6,000,000 roofing tile, and 4,000,000 building-brick per year.

As the building program develops a modern brick and tile plant should be built in the vicinity of each of the larger cities.

(d) Light-weight aggregate. The Rangoon area is entirely an alluvial delta area, and is therefore entirely devoid of proper aggregates for concrete use. Aggregate is shipped from the limestone deposits near Moulmein, or from the granite deposits near Mokpalin. Gravel obtainable is not suitable for good concrete, being of a narrow size range, and too fine. The only other aggregate in use in this area is broken brick-bats. These are of poor quality and are not comparable to good gravel or stone.

Sand used in Rangoon is of poor quality, being almost all one size, and very fine.

The Rangoon area has abundant deposits of clays suitable for the manufacture of clay brick and tile. Such clays are also ideal for the manufacture of light-weight aggregates. The use of light-weight aggregates manufactured from clays and other common materials has become important in the construction industry, particularly in the United States, where it is made and sold profitably in areas where good stone and gravel aggregates are readily available at normal prices.

Such manufactured clay aggregates are freely used in building construction and in concrete products. Being light in weight and of normal strength, their use permits smaller columns and beams, which reduces construction costs sharply. The concrete products made with such aggregates are lighter in weight and are more easily handled.

The principal advantage of using such aggregates in the Rangoon area would be that of supplying a better and graded aggregate at less cost. Its use would reduce the amount of Portland cement required, because it would be of a proper size gradation, permitting the design of concrete of higher strengths. The use of common building brick-bats is a crude substitute for the same type of product.

The manufacture of light-weight aggregates from clays is a simple procedure. It consists of working the clay, sizing it, and burning it in a small rotary kiln. The cost of such a plant would be small, compared with other industries, as the machinery should not cost more than K10,00,000. A plant of this type should be constructed as a part of the new clay tile and brick plant.

(e) Rock wool insulation. Another product needed in Burma, and which can easily be made in this country, is rock wool insulation. Aside from the basha thatched roofs used, all other types of roofing require insulation to prevent undue heat transmission.

Rock wool insulation is manufactured from shales or low-grade limestones. The process consists of melting the raw material and then spraying it into the air. The resulting solidified material is an excellent insulator that is permanent, cheap, and fireproof.

Such a plant could be made a part of the brick and tile plant being constructed. The cost of the equipment would be comparatively very small, probably not over K2,50,000.

(f) **Clay drain tile.** No clay drain tile is manufactured in Burma, yet an important quantity is required. There are two types needed, the common baked tile, and the glazed tile. These can be made as easily as roofing tile or building-brick, and with the same equipment. The glazed tile requires the use of salt.

These products are commonly used for water drainage, and for sewage lines.

(g) **Hollow building-tile.** Clay tiles of this type are made and used in two ways. One is for interior partitions. These are light in weight and have good structural properties.

Another use is for exterior walls. In this case the exposed exterior surface is given a special treatment to make it more pleasing to the eye. Its use is economical and results in a wall having good insulating qualities due to the air spaces.

(h) **Ceramics.** There are numerous clay pottery and glazed pottery plants in Burma. None of these are large, and many are of cottage industry size. No statistics exist regarding the total output. None manufacture vitreous china, at least of the type required for bathroom and kitchen use.

Good kaolin has been found in commercial deposits in upper Burma. A modern ceramics plant to manufacture tiles, flat tableware, art pottery, and industrial shapes would cost K1,23,94,720. Further study is recommended to develop this project and to determine its economic aspects.

(23) Glass Products Plant

(a) **The market.** Currently there are no facilities in the Union of Burma for the manufacture of flat glass, and only limited facilities for the manufacture of other glass products. Consequently most of such products are imported. This requires the allocation of a considerable block of foreign exchange, and the resulting arbitrary costs and selling prices restrict the use of glass products.

The volume of imports of glass products has reached a sustained level that is great enough to warrant the establishment of a national glass products industry. The demand for all glass products is certain to increase by normal growth as well as from the large-scale housing and building program now being started.

The past and present use of glass is shown in the table of glass products imports, Table XXII–17.

The housing program alone will account for a great deal of the demand for flat glass products. While many homes in Burma are of the type that do not use glass, the new Pucca and all-timber houses to be constructed will require glass. The estimated number of these to be built is as follows:

Year	*Pucca*	*All-timber*
1952–53	1,828	22,832
1953–54	2,335	23,930
1954–55	2,842	25,028
1955–56	3,349	26,126
1956–57	3,856	27,224
1957–58	4,364	28,336
1958–59	4,871	29,430
1959–60	5,378	29,532
Total	28,823	212,438
Average	3,603	26,555

For each new house built it is estimated that 150 sq. ft. of glass will be used. This would require 4,523,700 sq. ft. or 2,343 long tons per year. Normal replacements, remodeling older houses, office, factory and public building construction and maintenance would require an approximately equal amount.

Import figures for flat glass, and estimates of new future needs, indicate that a flat glass plant to manufacture 5,000 long tons per year should be built.

(b) **Raw materials.** The principal raw materials required for the manufacture of glass products are the following:

Silica Sand	40%
Soda Ash	15%
Cullet	35%
Dolomitic Limestone	8%
Various	2%
	100%

The 2% of "various" ingredients shown above consists of the various chemicals utilized in each batch to insure desired physical and chemical qualities in the finished glass. The quantity of each is so small that their use has little effect upon the manufacturing costs.

(1) *Sand*

Deposits of sands for use in the manufacture of glass products have been located in the Mergui district, both on the mainland and on islands nearby. This area is approximately 330 miles south by east from Rangoon.

An investigation of some of these glass sand deposits was made in May 1952. A summary of the results of this investigation with respect to quantity of the sand deposits is as follows:

Reference	*Deposit*	*Estimated Quantity (cubic yards)*
A	Thegon and Panoyo	272,000
D	Selengyi Sakan	13,000
F	Thedangyi	6,000
G	Tatange Island	13,000
	Total	304,000
		or 366,000 long tons

At an annual rate of use of 5,000 long tons per year for 10,000 long tons of glass, these deposits would last 73 years.

(2) *Soda ash*

Soda ash will be manufactured near Akyab, which is about 500 sea miles from Rangoon.

(3) *Cullet*

Cullet (broken glass) will originate in or near Rangoon.

(4) *Dolomite*

Dolomite is available in Burma in several locations, but none is near Rangoon. The Department of Geology reports a 3,000-foot thick deposit in the deep gorge of Namtu, near Lema, north Shan States, and a second deposit of the same thickness at the south end of Great Scuff, south of Kyaukkyan, north Shan States. The average analysis of this dolomite is:

$CaCO_3$	55·84%
$MgCO_3$	43·05%
Fe_2O_3 and Al_2	0·54%
Insolubles	0·57%
	100·00%

A third deposit is in the neighborhood of Loian, near Kalaw, in the southern Shan States, about 360 miles from Rangoon, by rail. High calcium limestone

TABLE XXII – 17

IMPORTS OF GLASS AND GLASS PRODUCTS

Fiscal Year	*Sheet and Plate Glass*		*Phials and Sodawater Bottles*	*Other Bottles*	*Tableware including Tumblers, Decanters*	*Funnels, Globes, Glass Lamp Parts*	*Hardware Lamps and Glass*
	Long Tons	*Sq. Ft.*	*Gross*	*Gross*	*Kyats*	*Kyats*	*No.*
1936–37	1,163	2,132,438	2,895	58,919	1,13,136	88,014	268,901
1937–38	1,504	2,847,447	5,399	89,583	60,212	1,08,258	223,593
1938–39	862	1,564,385	2,924	63,488	54,000	1,08,197	105,356
1939–40	1,250	2,453,519	3,618	81,099	49,160	1,23,432	186,759
1940–41	841	1,392,868	5,994	65,820	36,427	1,22,399	53,702
Prewar Total	5,620	10,390,657	20,830	358,909	3,12,935	5,50,300	838,311
Prewar Average	1,124	2,078,131	4,166	71,782	62,587	1,10,060	167,662
1945–46	Nil	Nil	208	7,627	1,30,633	66,855	Nil
1946–47	656	1,033,195	179	40,879	3,34,616	2,01,836	9,702
1947–48	3,498	3,765,260	635	39,349	3,23,849	1,94,226	931
1948–49	303	472,658	Nil	27,464	1,15,892	41,276	4,914
Postwar Total	4,457	5,271,113	1,022	115,319	9,04,990	5,04,193	15,547
Postwar Average	1,114	1,317,778	255	28,829	2,26,248	1,26,048	3,887
1949–50*	400						
1950–51	600						
1951–52	800						
1952–53	1,000						
1953–54	1,200						
1954–55	1,500						
1955–56	1,600						
1956–57	1,700						
1957–58	1,800						
1958–59	1,900						
1959–60	2,000						

* Estimated.

can be obtained from deposits near Moulmein, about 80 miles from Rangoon.

(5) *Fuel*

Good natural gas is the most desirable fuel but will not be available. Oil has the next most desirable characteristics, but while the tank furnace may be fired on heavy oil of the Bunker C type, light oil of the diesel type will be required for the debiteuse kiln in the sheet glass plant and for the lehrs in the container plant, and is greatly preferred for the feeders in both types of glass manufacturing plants. If any of the various types of coal are to be employed, then a producer gas installation is required. Raw producer gas may be employed for the tank furnace, but the lehrs and debiteuse kilns require scrubbed clean gas. Imported coal generally originates in India. No data are available concerning the producer-gas qualities of this coal.

Kalewa coal, when the mine is developed, can be delivered at Rangoon below the cost of imported coal. Therefore if coal is to be used, a quantity should be shipped to a testing plant to determine its gassing characteristics, as the design of the tank furnace, as well as the lehrs and debiteuse kiln, is dependent upon the analysis and characteristics of the producer gas.

(c) **Glass manufacturing plant location factors.** As no existing glass plant facilities are to be incorporated in the proposed new glass products plant, there are no restrictions to prevent the establishment of the plant in the most favorable location that will result in the lowest manufacturing and distribution costs.

The factors influencing the selection of this ideal site are:

Purchase cost of materials and fuel.
Cost of transportation of raw materials and fuel from point of purchase to plant site.
Cost of transportation from point of manufacture to major market areas.
Availability of labor.
Cost of site and its improvement.

A preliminary check indicates that it would be cheaper to bring all of the necessary materials together at Rangoon than it would be to collect them at Mergui. The freight and breakage in shipping the finished products to Rangoon, the major Burma market, would be eliminated. The proposed plant should be located at Rangoon.

Because the silica sand, the soda ash, the lime, and the fuel must be brought in by water transport, the plant site should be on the north or east bank of the Rangoon or Hlaing River. Such a site would also permit railway and truck transport, as well as water transport, without having to cross the river.

(d) **Products.** Burma imports almost all types of glass products and while all of these are needed, it is doubtful that there is sufficient demand for each one to warrant the expense of installing the special equipment required to manufacture all of them initially.

These products classified by processes are:

Flat Glass
Bottles and Containers
Pressed Ware
Paste Mold Ware
Glass Tube Ware
Insulation Products
Vitreous Enamel Products.

The proposed plant has been restricted to the manufacture of flat glass and bottles and containers. The equipment for manufacturing the other products is not included in the proposed plant but may be added as the demand for these products justifies.

(1) *Thin glass*

This includes glass weighing less than 16 ounces per square foot, i.e., less than one twelfth inch in thickness, and includes watch-crystal glass (one thirtieth inch to one twelfth inch), lantern-slide glass (one twentieth inch), microscope-slide glass (one twenty-fifth inch), photographic dry-plate glass (one fifteenth inch), X-ray and picture glass (one thirteenth inch).

(2) *Common sheet (window) glass*

This type represents the great bulk of production and includes principally single-strength glass, weighing from 16 to 19 ounces per square foot (one twelfth inch to one tenth inch), and double-strength glass, weighing from 24 to 26 ounces per square foot (one ninth inch to one eighth inch). Such glass is used largely for glazing windows and doors of dwelling houses, for hot beds, cold frames, skylights, conservatories and greenhouses.

(3) *Heavy (crystal) sheet glass*

This type includes glass weighing over 26 ounces per square foot (over one eighth inch thick). The most common types in this glass are three fifteenth inch, seven thirty-seconds inch, and one quarter inch in thickness. This glass is used in automobiles, in showcase windows, for table tops, and elsewhere.

Not included in the sheet glass production are the many forms of structural sheet glass, such as wired glass and polished plate glass, both of which are produced by entirely different processes and equipment.

(4) *Flat glass weights*

The following are the weight, area, thickness ratios:

Thickness	*Ounces per square foot*
Single Strength ($\frac{1}{12}$ in. to $\frac{1}{10}$ in. thick)	16–19
Double Strength ($\frac{1}{9}$ in. to $\frac{1}{8}$ in. thick)	24–26

One square foot of single strength sheet glass (2 to 2½ mm. thick) approximates 1·16 pounds. One metric ton is approximately equivalent to 170 square meters, or 1,900 sq. ft.; 1,700 sq. ft. to a 2,000-pound ton, and 1,930 sq. ft. to a long ton of 2,240 pounds.

The following table shows the maximum production of three standard Fourcaults drawing standard size sheets. These figures are based on good glass and continuous operation. The use of 300 operating days per year provides an 18% margin from estimated maximum production for the annual production.

(5) *Bottles and containers*

The bottles and containers will be produced in two machines having a combined capacity of about 120,000 gross per year of assorted sizes and shapes. One unit will be capable of manufacturing containers in sizes from half ounce to 64 ounce capacity including wide-mouth screwtop jars. The second unit will form containers of from quarter ounce to 8 ounce capacities, including narrow neck and slim wide-mouth bottles.

If large containers are required, a third unit will be needed, but the cost of this unit is not included in the initial plant.

(6) *Pressed ware production*

The manufacture of pressed glassware can be included in the proposed glass plant, although such a division is not included in the estimate of costs. This would include hollow glass building-blocks.

(7) *Paste mold ware*

The manufacture of paste glassware can also be included in the proposed glass plant, but is not being included in the initial estimate.

(8) *Glass tubing and rods*

The manufacture of glass tubing and rods can be done in the proposed glass plant if additional equipment is included. At present this can be delayed, so the necessary equipment is not included in the estimates of cost.

PRODUCTION PER MACHINE
(Square feet)

Daily Figures Based on 24 Hours

Annual Figures Based on 300 Days

	60-in. Machine	*84-in. Machine*	*100-in. Machine*
	48 in. Trimmed Width	*72 in. Trimmed Width*	*88 in. Trimmed Width*
·091 in. Thickness			
Speed, in./min.	42 in.	42 in.	42 in.
Hourly Production	840 sq. ft.	1,260 sq. ft.	1,540 sq. ft.
Daily Production	20,160 ,, ,,	30,240 ,, ,,	36,960 ,, ,,
Annual Production	6,048,000 ,, ,,	9,072,000 ,, ,,	11,088,000 ,, ,,
⅛ in. Thickness			
Speed in./min.	27 in.	27 in.	27 in.
Hourly Production	560 sq. ft.	740 sq. ft.	904 sq. ft.
Daily Production	13,440 ,, ,,	17,760 ,, ,,	21,696 ,, ,,
Annual Production	4,032,000 ,, ,,	5,328,000 ,, ,,	6,508,800 ,, ,,
¼ in. Thickness			
Speed in./min.	12 in.	12 in.	12 in.
Hourly Production	240 sq. ft.	360 sq. ft.	440 sq. ft.
Daily Production	5,760 ,, ,,	8,640 ,, ,,	10,560 ,, ,,
Annual Production	1,728,000 ,, ,,	2,592,000 ,, ,,	3,168,000 ,, ,,
Daily Pull (full width sheet)	15 tons	21 tons	25 tons

(9) *Other products*

(*a*) *Insulation products*

Glass Wool
Rock Wool
Foam Glass.

(*b*) *Vitreous enamel products*

Glazed Building-tile
Sewer and Drain Pipe
Ceramic Tableware
Vitreous Enameling Plants
Building-brick
Silicate of Soda.

It is not intended to include the manufacture of these products in the initial plant, so the cost of the equipment is not included in the estimates.

(e) **Description of process.** The principal raw materials, silica sand, soda ash, lime, and broken glass (commonly called cullet) are ground or pulverized and thoroughly mixed together in accurately maintained proportions. The batch mixture is fed automatically to the glass-melting tank furnace to maintain the level of the molten mixture in the tank within one tenth of an inch, in good operating practice.

In the tank furnace the batch is melted, refined and conditioned in a continuous operation during which the material passes from the charging end to the exit, or machine feeding end.

From the feeding end the glass is drawn vertically in a sheet six to eight feet wide and solidifies in the process. The drawing equipment is known as the "Fourcault machine" after its Belgian inventor.

The continuously rising sheet is cut transversely near the top of its travel and is then sent to the cutting room for trimming and cutting to the desired dimensions.

The process described is called "the Fourcault system" which produces most of the world's sheet glass.

(1) *Glass-melting tank furnace*

The batch materials are charged into one end of a large "tank" built of refractory blocks. Rectangular in shape, the tank usually contains from 500 to 1,500 tons or more of molten glass. The tank is somewhat similar to an open hearth steel furnace.

At operating temperatures of 2,800° F. the demand on the refractory materials is great. The quality of the glass and the life of the furnace depend upon the quality of the refractory materials. The tank blocks are continuously subject to corrosion, erosion and chemical decomposition. The life of the tank blocks varies greatly with the skill with which the furnace is operated and the furnace design. Good design and good operating practice may multiply the life of the furnace by a factor of four or an even larger figure.

(2) *Sheet glass cutting*

There is available some automatic equipment for cutting and packing sheet glass, but a large percentage of sheet glass is cut and packed by hand. It must be determined in individual circumstances whether the possible salvage of sheet glass by selective hand cutting outweighs the advantages of the lower operating cost of semi-automatic equipment. Hand cutting requires a great deal of space for the individual cutting tables on which this operation is usually accomplished.

(f) **Estimated costs.** It is estimated that the capital required to establish a plant to manufacture 5,000 long tons of flat glass, and 120,000 gross of assorted containers, per year, will be as follows:

Flat Glass and Bottle Plant	*Estimated Cost* (K)
Raw Material Storage Equipment	2,83,200
Raw Material Preparation Equipment	3,54,000
Batch Mixing Equipment	3,54,000
Flat Glass Furnace Equipment	9,44,000
Container Glass Furnace Equipment	4,72,000
Flat Glass Drawing Equipment	3,77,600
Container Glass Molding Equipment	3,77,600
Debiteuse and Floater Kiln	70,800
Lehr Machine and Equipment	2,26,560
Cutting Tables	94,400
Mold Cleaning Equipment	23,600
Elevating and Conveying Equipment	94,400
Compressed Air System	1,88,800
Vacuum System	47,200
Fuel Oil System	1,41,600
Water Cooling Tower and Water System	1,41,600
Standby Power Plant Equipment	4,00,000
Electrical Distribution Equipment	2,36,000
Laboratory Equipment	70,800
Office and Stores Equipment	70,800
Shop Equipment and Tools	3,54,000
Box Making Equipment	70,800
Sewage and Sanitary Equipment	94,400
Automotive Equipment	1,18,000
Total Equipment	56,06,160
Buildings and Structures Material	11,80,000
Ocean Freight	7,08,000
Insurance	1,32,160
Duty	—
Rental on Construction Equipment	3,54,000
Living—Travelling Expense of Foreign Experts	3,54,000
Construction Overhead	3,30,400
Contingencies	7,20,000
Engineering-Erection-Construction	23,60,000
Total Cost except Real Estate	1,17,44,720
Real Estate—Plant Site and Raw Materials	5,87,280
Total Erected Cost	1,23,32,000
Working Capital	23,60,000
Total Capital Required	1,46,92,000

(g) Construction and expenditure schedule. It is estimated that it will take about 20 months to complete the proposed plant from the time the preliminary design has been completed, the raw materials and fuels checked. The machinery can be shipped from six to eight months after the order is placed.

(1) *Procedure*

A consultant should be employed to make the preliminary design, test the raw materials, select the plant site, and to prepare machinery specifications. This should require about four months.

The plant site should then be purchased and grading started. Upon completion of general drawings and foundations drawings, construction can start.

(2) *Expenditure schedule*

Of the estimated cost of K1,46,92,000, approximately K93,17,000 will be required in foreign currency and K53,75,000 in local currency.

(3) *First year expense*

The principal first year expenditures will be for engineering, material testing, acquisition, and improving plant site and raw material deposits, and for advance payments on machinery and materials. These are estimated to be K77,88,000 of which K59,00,000 will be in foreign currency and K18,88,000 in local currency.

(4) *Second year expense*

The expenditures for the second year will be K34,17,000 in foreign currency and K34,87,000 in local currency.

(h) Manufacturing costs. The manufacturing costs have been estimated as shown on the following table XXII–18.

TABLE XXII – 18

ESTIMATED COST OF SALES AND PROFIT

Sheet and Container Glass

	Flat Glass	*Per L.T.*	*Container Glass*	*Per L.T.*	*Per Gross*
	K	*K*	*K*	*K*	*K*
1. Operating and Repair Labor	2,00,000		3,57,000		
2. Operating and Repair Supplies	60,000		40,000		
3. Silica Sand	1,50,000		60,000		
4. Soda Ash	1,80,000		72 000		
5. Cullet	42,000		16,800		
6. Dolomite	24,000		9,600		
7. Miscellaneous	24,000		9,600		
8. Fuel	3,42,500		1,37,000		
9. Power	5,00,000		2,00,000		
10. Water	15,000		6,000		
11. Boxing and Packaging Materials	75,000		30,000		
12. General Works Expense	3,75,000		1,50,000		
13. Administration and Sales	3,75,000		1,50,000		
14. Amortization of Capital Loan	6,00,000		4,05,095		
15. Insurance	75,000		30,000		
16. Cost of Sales	30,37,500	606.25	16,73,095	836.55	13.94
Quantity	(5,000 L.T.)			(2,000 L.T.)	(120,000 Gr
17. Gross Sales	25,71,650	514.33	18,00,000*	900.00	15.00
18. Add for Breakage	2,57,165	51.43	—	—	—
19. Total	28,28,815	565.76	18,00,000	900.00	15.00
20. Stevedoring and Warehousing	2,26,305	45.26	—	—	—
21. Gross Total Sales	30,55,120	611.02	18,00,000	900.00	15.00
22. Less Cost of Sales	30,37,500	606.25	16,73,095	836.55	13.94
23. Gross Profit	17,620	4·77	1,26,905	63.45	1.06

*Estimated. No data available from import records for containers alone.

The estimated cost of flat glass is very close to the estimated ex-warehouse cost of UK and Belgian imported glass, less duty and profit to dealer. Japanese prices are below the UK and Belgian prices checked, for flat glass. No accurate costs of imported bottles could be obtained from the import figures available.

The distances it is necessary to transport the silica sand, soda ash and dolomite make the manufacturing costs higher than normal.

(i) **Recommendation.** This project is marginal from the viewpoint of financial return but justifies consideration from the viewpoint of self-sufficiency in an essential commodity. It is recommended that the project be considered for implementation in the intermediate plan. Improvement in transportation facilities and lower costs of transportation services and electric energy will enhance the economic feasibility of the project.

(24) Sand and Gravel

Sand and gravel are elemental construction materials. Sands are used in all concrete and are required for many other purposes such as surfacing macadam and black top roads and streets.

Sands are generally available in every area and their recovery is normally a simple operation. Because of its general abundance, construction sand is usually not shipped far.

The sands in the Rangoon area are not of the best grade as they are too fine and the size is too uniform. The best sands for concrete use are graded, all of them passing a quarter inch screen, and 95% passing a 100-mesh screen. Such graded sands are normally not found in slow moving rivers or on sea shores as the water grades the sand by size and deposits only one size in any one spot.

The demand for construction sand in the Rangoon area is great enough to warrant the construction of a suitable plant. At present about 80% of all Portland cement used in Burma is sold in the Rangoon area. This amounted to approximately 60,000 long tons for the year 1951–52. This is sufficient to produce about 240,000 cubic yards of rammed concrete. As each cubic yard of concrete requires approximately 0·50 cubic yards of sand, an annual total of 120,000 cubic yards of sand is needed.

Other uses, for road surfacing, etc., would bring this total up to at least 200,000 cubic yards per year in the Rangoon area alone. This would total more than 225,000 long tons (dry basis).

Good construction sands must be washed to remove all loam or organic materials that might injure concrete. Such organic materials as sewage, vegetable matter, tannic acid and manure must be removed. Good sands must be of hard materials such as quartz. Sands may be obtained from sand deposits or by screening from gravel.

A sand plant is a simple plant. It normally consists of excavating equipment to suit the deposit conditions, of washing and screening equipment, and of conveying equipment. Gravel plants are similar except that more screens are required and sometimes crushers if much of the gravel is over two to three inches in size.

A moderate sized sand plant is not expensive, and should not exceed K3,00,000 for the equipment if a sand drier is not installed. A gravel plant would cost about twice as much. While no good deposit of sand is known in the Rangoon area, a search should be made to find one.

(25) Precast Concrete Products

Precast concrete products are used in Burma on a limited scale only, and not all types of such products are used or manufactured. The most commonly used precast concrete products are:

Masonry Units
Roof Tile
Structural Members
Poles and Piling
Concrete Pipe.

(a) Concrete masonry. The term "concrete masonry" applies to block, brick, and tile building units molded of concrete and laid by masons in walls. Plants for the manufacture of those units are commonly of moderate size, established in many locations. As the products may usually be made in all localities the plants usually serve the local community only, so that the products are not shipped very far.

For example, in the United States and Canada there are about 4,500 such plants producing over 1,500,000,000 units per year. About 40% of these are produced with light-weight aggregate. As far as is known, only concrete blocks are produced or used in Burma. The only known active plant is one in Rangoon, which has a capacity of 1,200 standard block per eight-hour day, or 2,400 blocks of half thickness. If operated 300 eight-hour days per year this plant would have an annual minimum capacity of 360,000 standard block per year.

The Rangoon block price is K80.00 per 100, which compares to the current clay brick price of K125.00 per 1000. As one concrete block occupies the same wall space as eight clay bricks, the prices are nearly equivalent. The small volume price differential is more than offset by the lower cost of handling and mason labor and by the fact that much less mortar is required in the laying.

Buildings constructed of concrete blocks compare well in cost with those of the same size and type constructed of other materials. An example is the two concrete block units constructed in the Minmanaung Kwethit housing area. These, with concrete floors, cost K8,500 each. The balance of the buildings in this group, constructed on a large-scale contract basis, of timber and woven matting construction and without concrete floors, are reported to have cost K5,400.00 each. One type is fireproof and permanent, while the others are not. There is no question but that if the concrete block houses were to be erected on a large scale, if the lintels and trim were precast, and if the design were simplified a little, these could be produced at about the same cost as the other type.

A two-machine block plant will cost about K75,000 for the equipment. The labor is largely unskilled, and only about four men per machine are required. Blocks can be constructed at a good profit at the present price.

As the cost of a single machine unit is small, many of these could be installed in the principal towns of Burma at little total cost, thus providing wide distribution of a good building construction product without excessive freight charges. Usually the aggregate can be found in all locations, and only the Portland cement need be shipped in. Cement costs would be higher than at Rangoon by the freight costs to the plant.

This would be better than using local clay brick at each town as the local brick are of poor quality. It would also not be practical or economical to ship the clay brick from the new clay products plant in Rangoon.

Where available, the use of light-weight aggregate would be best. The standard concrete block weighs about 45 pounds when made with natural aggregates, but only from 25 to 30 pounds when the light-weight aggregate is used. The weight of the blocks is generally the main objection to their use.

Concrete bricks are widely used elsewhere, but not in Burma. These can be made in the same type of machines as the block and are superior to the clay brick in strength and appearance. Concrete wall tiles for partitions are as easily made.

In many countries precast floor and wainscot tile are used as much as clay tile. These can be made with colored aggregates in many patterns, and when ground like terrazzo, are extremely attractive. A good market for these could be built up in Burma.

(b) Concrete roof tile. Another precast concrete product that can be made economically in Burma is concrete roofing tile. These can be made in several shapes including exact duplicates of the clay tile. These may be colored if desired. The cost would be far below that of the imported clay roof tile, and should be competitive with the tile produced in the new government tile plant in Rangoon. As these can be made in any location little breakage would occur and there would be no freight to add to the cost, except for the Portland cement. When properly made they are equal to the clay product, and cost no more.

(c) Precast structural members. Standard precast structural members are logical units to manufacture in Burma. These would include floor beams, floor joists, floor slabs, windows and door sills and lintels, sanitary toilet slabs, and well, cistern, and cesspool cover slabs, drainage ditch covers, highway railing and markers, and revetment blocks.

Only covers for drain ditches are used now in Burma. The use of such precast units results in important reductions in cost compared with tailored units built in place, as they save in form costs and in placement labor.

This use has greatly reduced the cost of houses and other structures in the United States and elsewhere, and can do the same in Burma.

(d) Precast poles and piling. The construction of the large electric power distribution system in Burma will require a great number of poles for both feeder and distribution lines.

Timber poles are practical if the poles are treated against rot and insects. Even so the life expectancy of wood poles is short. Wood towers for the main distribution lines are not practical. Such line supports must therefore be made from imported structural steel, or be made of precast concrete as is commonly used in Italy.

The smaller precast concrete poles for power, light and telephone lines are more economical in the long run due to their longer life and lower maintenance costs. Their uniformity also adds to the appearance of any such line installation. Some poles of this type are in use now in Burma. This type of pole may be cast in various locations along the route of power lines to save freight costs.

The river and harbor work being planned will require the use of much piling. The number and cost of such piles may be decreased if precast piling are used. These are standardized and are used on all important marine structures throughout the world. Experience has proved that the use of these precast concrete piles is economical in the long run. Portable plants for their construction are easily erected.

(e) Concrete pipe. There is a real need in Burma for a plant to manufacture concrete pipe. All pipe used in Burma is imported, and although a steel products plant is projected for Burma, it is not planned to manufacture pipe in it.

For many purposes concrete pipe is cheaper than, and equal to, steel or cast iron pipe. The principal uses are for water and sewage lines, drainage and irrigation systems, and for culvert work. Practically all concrete pipe is reinforced. Almost all large water aqueducts are made of reinforced concrete conduit, either cast in place or precast.

No clay drainage or sewer pipe is manufactured in Burma. Therefore the pipe market for such uses is completely open, and can be most easily supplied by concrete pipe.

Every non-basha type house requires drain pipe for conducting rain water away from the house. Sewage lines are required for each house, and toilet and kitchen vent pipes are required. All of these requirements can be supplied economically and satisfactorily by precast concrete pipe. As it is planned to construct 240,000 houses of this type during the next ten years, the demand for such pipe will be great. If only 100 ft. of pipe is used per house unit, a total of 24,000,000 lineal feet will be required, or 2,400,000 ft. per year as an average.

In addition, new water and sewage mains outside of private property lines will require much pipe, and of a larger size. It is easily possible that a minimum of 3,000,000 lineal feet will be required per year.

The highway program outlined in Chapter XVI will require 370,500 lineal feet of 18-in., 24-in., 36-in. and 48-in. drain tile in the next ten years.

A single unit, manufacturing spun reinforced concrete pipe, will produce about 300 lineal feet of pipe per eight-hour day, or about 90,000 lineal feet per year. As such plants are relatively inexpensive, they could be established in all localities where they might be most useful. The manufacture of such products in small local plants is not only practical, but results in the delivery of first grade pipe with little breakage and at cheaper prices than can be the case when other types of pipe must be shipped long distances from large central plants, or ports of import.

Culverts in Burma, under highways and railroads, are generally made of brick. These are much more expensive than reinforced concrete culvert pipe.

From the estimated market, about 33 pipe units are needed. However, as no one type of pipe will be used exclusively, only a part of the estimated demand will be supplied by precast concrete pipe. Therefore fewer than 33 units will be required.

It is recommended that an initial unit be established in Rangoon. As an asbestos cement pipe and sheet plant is also recommended, it is desirable to install the cast concrete plant as a department of the larger plant, which will effect economies in both investment and production costs.

Accordingly, the estimated investment costs have been incorporated in with those of the Asbestos-Cement Products Plant, under Project 30.

(26) Ready-mixed Concrete

The use of ready-mixed, or transit-mixed concrete is growing rapidly in all areas where there is a market great enough to support the operation of a plant.

As a general rule such concrete is superior to that made on the job. This is particularly true when its use replaces hand labor methods of proportioning and mixing. For larger jobs it eliminates the necessity for the contractor to invest in proportioning and mixing equipment which is idle much of the time. Its use also eliminates the necessity of reserving large areas of construction property or of city streets for storing aggregates and cement, and eliminates the cost of handling these materials.

It has been found to be profitable in most cities in the United States having a population of 15,000, or greater, and should be very profitable in Rangoon and Burma.

A ready-mixed concrete plant is designed to meet every specification, and to deliver it at the job site when wanted, at a price below that for which it can be prepared on the job.

This can be done because such a producer buys his materials in large quantities at a minimum cost, handles them mechanically at low cost, proportions accurately by scales, and because, above all, he keeps his equipment busy as in any manufacturing plant. This last is very important, as most contractors have yards full of special equipment that is idle most of the time. Such construction equipment is expensive, and thus the depreciation charges on it must be high whenever in use. This makes the use cost very high.

In order to reduce the over-all cost of delivered ready-mixed concrete, producers generally purchase their Portland cement direct from the manufacturer in bulk, without sacks. This not only reduces the cost by eliminating the cost of the paper bags, but reduces handling labor cost. In Burma, paper bags for cement cost approximately K16.70 per long ton of cement. The cost of handling and of warehousing cement in sacks in Rangoon is K6.03 per long ton. If the sack cost could be eliminated by the shipment of cement in bulk, and if the handling and warehouse cost in Rangoon could be reduced to about K1.00 by bulk handling methods (which is all it should cost), the bulk cement user should reduce the cost of cement by K21.73 per long ton. This is a reduction of 13% from the cement price of K168.00 per long ton, in sacks, ex warehouse in Rangoon.

If delivered by the cement company in bulk barges, owned and operated by them, further reductions in packing costs at Thayetmyo, and in freight, could be made and the savings passed on to the consumer. This would greatly stimulate the use of concrete in Rangoon.

Initially, when bulk cement is available, to save duplication of equipment and facilities, it would be best to have one central bulk cement unloading and storage station. This could well be owned and operated by the cement company itself, as bags could be filled here for all non-bulk sales in the Rangoon area.

All concrete products plants using bulk cement should be on the same, or closely adjacent property, so that bulk cement could be pumped through pipelines to each such plant as required.

A common aggregate storage yard should be a part of the same set-up to minimize the cost of aggregates and of their handling. A ready-mixed concrete plant should be a unit of this group.

Such a plant is not expensive, aside from the trucks. The plant would consist of aggregate unloading and storage equipment, cement and aggregate bins, cement and aggregate proportioning scales, concrete mixer, and trucks. The cost of equipment without trucks would be about K5,00,000. The number of trucks is determined by the yardage to be sold and the average time required to deliver and return.

Almost all concrete roads, streets, airports, and runways are poured by such equipment, and it works just as well in cities where there is enough concrete used to keep a ready-mixed plant reasonably busy. It has been estimated that about 240,000 cubic yards of concrete are poured annually in the Rangoon area.

If 50% were to be supplied by a ready-mixed plant, the average daily output would have to be 400 cubic yards per eight-hour day.

As the quality of concrete produced in ready-mixed concrete plants is superior, and as it costs less delivered in forms, a plant should be constructed.

In the United States, as long ago as 1948, more than 25,000,000 cubic yards of ready-mixed concrete were produced, which had a value, at the point of delivery, of about $250,000,000, equivalent to $10.00 per cubic yard. In Rangoon, the price might be higher as the price of cement is much greater than in the United States, and aggregate costs will be higher.

(27) Limestone Products

Few limestone products, as such, are used in the Rangoon area. The principal one, lime, is presented later in this Report.

This section is confined to a discussion of unconverted limestone products such as:

Riprap (pitching stone)
Furnace Flux
Ballast
Aggregates
Agricultural Limestone.

(a) Riprap (pitching stone). Large rocks for this purpose are used normally for sea wall and river revetment work. In Rangoon there is little demand for such rock. In other areas rock produced locally can usually be found that is suitable for this purpose. A minor amount will possibly be required to protect some railway or highway fills. In any event such rock need not be limestone.

(b) Furnace flux. Limestone for furnace flux use may either be high calcium carbonate limestone, or high magnesium carbonate limestone, depending upon the process requirements. This is usually from 4 ins. to 6 ins. in size.

Both materials are available for use in Rangoon, but not from nearby deposits. High calcium carbonate limestone can be produced in the Moulmein area where extensive deposits of high grade limestone have been surveyed and mapped. These deposits are about 80–100 miles from Rangoon. High magnesium carbonate limestones are found in several of the Shan States. The nearest deposit is near Kalaw. This runs better than 40% $MgCO_3$. The limestone would have to be transported to Rangoon by rail.

No furnace flux will be required for use in any of the new industries being considered for the Rangoon area. Later, if iron ore of commercial grade is discovered in Burma, a blast furnace would be installed. Such an operation would require important quantities of flux limestone. The dolomite limestone (high magnesium carbonate limestone) will be required in the proposed glass plant, but in smaller size than flux stone grade.

(c) Ballast. Ballast for railways may be either a limestone, or any other hard rock, crushed and screened to the correct size. Railroads normally find enough deposits of suitable rock at strategic locations along their rights-of-way, and thus avoid long hauls to points of use. This size rock is usually produced on a contract basis, or sometimes in railroad-owned quarries. It is normally best for the railroads to purchase the ballast from contractors or other producers, who can sell the smaller sizes not suitable for ballast.

In any event, all ballast used in the Rangoon area must be shipped in. In the Railway Section of this Report, Chapter XI, it has been recommended that 572 miles of track be relaid with 60-pound rail. Each mile of new meter gauge track will require at least 2,000 cubic yards of ballast. The ballast requirements for restoring railway roadbeds to proper condition have been estimated at 15,000,000 cubic feet (555,555 cubic yards), and much of this will be required in the Rangoon area.

Included as ballast for estimating purposes is crushed rock for highway surfacing. The highway construction work outlined in Chapter XVI will require 17,312,000 tons (15,000,000 cubic yards) of crushed rock for base and surface use in the next ten years. While this must come from quarries close to the job site, the quantities are large.

(d) **Aggregates.** Aggregates are the fine and coarse-graded rock or gravel required in making concrete. As fine aggregates are usually natural sands, they are not considered in this section. Coarse aggregates are commonly produced from gravels or from hard rock deposits.

It is estimated that 240,000 cubic yards of rammed concrete are poured in the Rangoon area each year. Each yard of concrete requires about 0·90 cubic yards of graded rock. Thus approximately 216,000 cubic yards of coarse aggregate, ranging in size from three quarters of an inch to three inches, will be required. The use of concrete will increase during the next ten years, and is expected to double by 1962.

The estimated present use of coarse aggregate in cubic yards is equivalent to about the same number of long tons per year. Such aggregates may come from granite, trap rock, limestone or gravel.

Both granite and limestone are available in the Rangoon area, at Mokpalin (on the mouth of the Sittang River), and at Moulmein, respectively. Each is about 80–90 miles from Rangoon, by water.

The Moulmein area has a number of extensive deposits that cover more than 200 square miles. These have been surveyed and mapped by the Government Geological Department. One deposit covering about 16 square miles is directly across the bay from Moulmein, and is on deep water. At present, this limestone is not sold in Rangoon as aggregate.

The aggregates commonly used are gravel, and brick-bats broken by hand. Neither makes good aggregate. The gravel is too fine and is too uniform in size. The broken brick-bats are not hard enough to develop proper strengths.

(e) **Agricultural limestone.** It is believed that the delta rice areas are acid as compared to the interior paddy areas. There is, however, no general agreement on the subject and further research will be required before the need for liming paddy soils can be established.

However, it is possible that at some future date it may be found desirable to lime at least some of the delta farm lands. The amount of lime applied per acre is dependent upon the soil tests. An average requirement of one ton per acre would not be unusual. At present there are about 10,000,000 acres under rice cultivation. If only 25% required liming, a large demand for agricultural limestone would result. As lime is not applied annually on each piece of land, the yearly demand would be about one third of the estimated total or

$$\frac{10{,}000{,}000 \times \cdot 25 \times 1}{3}$$

or 833,000 tons per year.

To produce this would require a crushing plant having a daily capacity of 2,775 long tons. On such a volume the cost per ton could be greatly reduced to about K3.00 per long ton f.o.b. plant.

(f) **Recommendations.** The limestone deposits in the Moulmein area should be developed with a crushing plant of at least 1,000 long tons capacity per day of screened, crushed rock of all sizes desired for railway, highway and concrete work. Such a plant with quarry equipment would cost about K5,00,000 for equipment only, and resulting production costs should not exceed K6.00 per long ton. However, the development of a quarry in the Moulmein area should be undertaken with a consideration of the entire limestone requirements of coastal Burma, including particularly the proposed plants discussed in sections C-1-b,(28) and C-1-b,(29). The development of these plants would require considerably larger quarry facilities, and would reduce production costs per ton.

(28) Portland Cement

(a) Existing Portland cement industry. The existing Portland cement industry consists of a small manufacturing plant having a rated capacity of 60,000 long tons of cement per year. This property is owned by Burma Cement Company, Limited, and is located at Thayetmyo. Burma Cement Company, Limited, was organized under the laws of Burma in July, 1935, and maintains its principal office in Rangoon. The company was organized and financed by a group of United Kingdom and Indian Portland cement manufacturing companies, and by Steel Brothers & Company, Limited. These same major owners still retain their controlling interests, with some stock being held by other private interests. Steel Brothers & Company, Limited, manage the plant under a "Managing Agent" contract.

All shipments from this plant are made in barges owned and operated by the Inland Water Transport Board of the Union of Burma, or on the combination freight and passenger steamers under the same ownership. The cement company does not now own or operate any barges, although it has done so in past years, and is allowed to do so now. Both rail and water freight rates are set by the Government, and are approximately equal for cement as far as the Rangoon shipments are concerned.

(b) Manufacturing operations—Thayetmyo. The Thayetmyo plant is a single-kiln, wet-process plant having a rated capacity of 60,000 long tons per year, 5,000 long tons per month, and 175–190 long tons per day, of "ordinary" Portland cement made in accordance with British Portland cement specifications. The plant is relatively self-sufficient in that it produces its own power and fuel (natural gas), in addition to the major raw materials.

The Thayetmyo plant is simple in design and arrangement, and is efficient by European standards. It was designed to manufacture a single basic type of standard cement of uniform quality in conformance with British specifications at a cost that is reasonable considering its design, equipment, capacity, and the local conditions. Additional units may be installed, if and when required, at a minimum of expense.

The major raw materials used at Thayetmyo are a high-calcium and a low-calcium limestone. The minor raw materials are silica sand and gypsum. All are procured locally.

Originally the Thayetmyo plant used natural gas from a small nearby field for all purposes, including steam generation and process use. Due to normal depletion and damage by the characteristic sliding formation of this field, the existing wells no longer supply the entire requirements when the kiln is operated at rated capacity. During the last fiscal year, the kiln was operated at a reduced capacity, and it was necessary to substitute fuel oil for the gas in the power plant at a considerable increase in cost.

The company has attempted to overcome this handicap by drilling new wells, the first of which was spudded-in in 1952. This well was recently completed at a cost over K3,00,000 but its output is not sufficient to relieve the situation. A second well has been started.

The economy of the Thayetmyo plant is dependent upon an ample supply of cheap natural gas. Due to an advantageous contract with the Government of Burma, the cement company has been paying (in addition to the cost of drilling, operating, and maintaining the gas wells) a nominal royalty for its gas fuel. This royalty is equivalent to 5% of the estimated cost (K135.75 per long ton) of imported coal delivered at Thayetmyo. The equivalent cost of coal is calculated to be K40.00 per long ton of cement; therefore the gas royalty is K2.00 per long ton of cement. If imported coal is used the manufacturing cost will increase by K38.00 per long ton of cement. This would represent an increase of 68% in the plant manufacturing costs at rated capacity.

This low cost of natural gas has enabled Burma Cement Company, Limited, to sell its product in Rangoon in competition with imported cement. As the present water freight rate from Thayetmyo to Rangoon is K38.92 per ton, it is apparent that an increase of K38.00 per long ton of cement would erase the advantage now enjoyed due to the Thayetmyo gas price, and could make it impossible to sell Thayetmyo cement against the price of imported cement, if this price were to be lowered. As from 75% to 82·5% of all sales of Burma Cement Company,

TABLE XXII – 19

PRODUCTION, SALES, IMPORTS, AND CONSUMPTION OF CEMENT IN BURMA

(Long tons)

*Fiscal Year Ending**	*Total Production B.C.Co. Ltd.*	*Total Sales in Burma B.C.Co. Ltd.*	*Export Sales B.C.Co. Ltd.*	*Total Sales B.C.Co. Ltd.*	*Imports*	*Total Burma Use*	*Average Declared Value of Imported Cement†*
1937	12,000	11,194	–	11,194	22,000	33,194	44.58
1938	56,500	35,517	16,039	51,556	9,000	44,517	47.20
1939	71,568	52,519	15,150	67,669	8,952	61,471	47.25
1940	62,898	56,132	4,372	60,504	4,518	60,650	56.90
1941	69,432	59,590	7,796	67,386	2,974	62,564	57.75
(1942–45—no data available)							
1946					7,601	7,601	100.50
1947					25,286	25,286	103.00
1948					40,812	40,812	110.00
1949	932‡				12,929	12,929	136.50
1950					20,118	20,118	118.00
1951	3,220‡				50,912	50,912	121.20
1952	35,891	31,889	—	31,889	35,100	66,989	142.90
Total	308,287	246,841	43,357	290,198	240,202	487,043	

*Prewar fiscal years end March 31. Postwar fiscal years end September 30.
†Average declared customs value, not landed or sales value, from GUB figures.
‡Estimated. Based on sales receipts.

Limited, are made in the Rangoon area, the situation is serious.

There are, however, three possibilities for maintaining a competitive advantage in the Rangoon market; (1) through the use of Kalewa coal, (2) through the use of fuel oil, (3) through more reasonable transportation charges.

(c) **Past and current market.** The use of Portland cement in Burma is shown in Table XXII–19 (*see previous page*), which shows the production and sales of Burma Cement Company Limited, and the imports.

Estimated Future Requirements of Cement in Burma

	L.T.
1953	68,000
1954	75,000
1955	85,000
1956	95,000
1957	105,000
1958	110,000
1959	115,000
1960	120,000
1961	125,000
1962	130,000

A great deal of the expected increase in the use of Portland cement in Burma will result from the execution of the economic development plan. For example, the three initial dams are estimated to require a minimum of 80,000 long tons of standard and special cements.

More than 240,000 houses of the non-basha type will be required during the next eight years. While many of these will use limited quantities of cement, all of them will require some. If only ten cwts. of cement are used per house unit, a total of 120,000 long tons will be required. Highways, culverts, bridges, docks, airports, public and private buildings, and industrial plants will require even greater quantities of this basic material. The estimated future requirements are considered to be conservative.

From an examination of the preceding table, it is evident that the current use has outgrown the capacity of the existing plant, and that it is necessary to expand the capacity of the national Portland cement industry, unless rapidly increasing future requirements are satisfied by imports.

(d) **Economics of importing Portland cement.** Importing the quantity required, over and above the capacity of the existing plant, will require a foreign exchange allocation of K6,12,04,000 over the next ten-year period. If the existing industry is expanded, or a new plant is built, the foreign exchange required would be respectively, K44,87,500 or K1,74,40,000.

The implementation of the development program will require large quantities of Portland cement. This commodity should be manufactured within the country. It is evident that if the enlargement of the existing industry is delayed, importation will be necessary. Therefore, to supply domestically the additional cement needs of Burma, the existing industry must be expanded immediately. This becomes a matter of choice between expanding the Thayetmyo plant, or of constructing a new plant elsewhere.

(e) **Location of a new Portland cement plant.** Rangoon is at present the major cement market in Burma, and uses from 75% to 82·5% of all Portland cement sold. It is also the distribution and shipping center of the country. Rangoon is thus the logical location for a second cement manufacturing plant. Its advantages and disadvantages are summarized below:

(1) *Advantages*

(*a*) The freight and handling charges for cement shipments from Thayetmyo to Rangoon amounting to K38.92 and K6.03 per long ton respectively would be saved.

(*b*) The freight charges on 5-ply paper bags, operating and repair supplies from Rangoon to Thayetmyo and a 4% breakage loss in handling bagged cement at Rangoon would be saved.

(*c*) The operation and maintenance of a river launch at Thayetmyo, required because of the absence of a rail or highway connection, would be saved.

(*d*) The cost of maintenance of quarters for managerial and supervisory staff and employees including expensive security protection would be saved.

(*e*) The cost of maintaining a landing strip required because of slow and insecure transport by river or rail between Rangoon and Thayetmyo would be saved.

(2) *Disadvantages*

(*a*) There are no limestone deposits in the Rangoon area, consequently crushed limestone would have to be transported from the nearest suitable source by barge or rail. The closest deposit of commercial proportions located to permit barge transport is near Moulmein.

(*b*) The cost of gypsum would be higher at Rangoon than at Thayetmyo. However, if it became necessary to use imported gypsum because of depletion of local sources, the Rangoon area would have the advantage.

(*c*) Labor rates are likely to be higher in Rangoon than at Thayetmyo.

(*d*) The cost of fuel for power and processing would be higher in Rangoon than at Thayetmyo, unless the latter plant has to resort to the use of coal or fuel oil in which case the two plants would have approximately the same fuel cost.

(*e*) A small plant at Rangoon could not manufacture the cement as cheaply as a plant of twice the capacity at Thayetmyo since the fixed costs would be distributed over one-half the production.

(*f*) A new company with a new staff would be necessary at Rangoon while the expansion of the plant at Thayetmyo would pose no management problems.

(*g*) The capital investment required for building a new plant at Rangoon would be approximately four times that of expanding the plant at Thayetmyo.

(f) Modernizing and enlarging Thayetmyo. The limestone quarry operation and limestone crushing and transportation system should be revised and modernized. These operations are largely manual and produce rock of larger size than is suitable for feeding grinding mills. The resulting costs are at least twice as much as they should be, and cause excessive use of power and labor in the grinding operations. The grinding circuits are obsolete and inefficient, resulting in additional power and labor waste and excessive fuel consumption.

The fuel consumption in the kiln is excessive. This is partially due to over-grinding the raw materials, partly due to the characteristics of the raw materials, and partially due to the design of the kiln itself. The clinker cooling system is obsolete and inefficient, thus compelling the use of excessive power and labor in the clinker grinding operations where over-grinding also occurs.

The finished cement storage system is completely inadequate for proper operation of the present plant in which only one product can be made. The packing and barge loading equipment is expensive to operate, and results in a 2% paper sack breakage which is about eight times normal practice. Proper unloading and handling facilities for any materials brought in by barge are lacking. If coal must be used, such facilities must be installed.

(g) Estimated costs. The cost of modernizing the Thayetmyo plant, doubling its capacity, and equipping it to manufacture special cements, has been estimated as shown in Table XXII–20.

TABLE XXII – 20

COSTS OF THAYETMYO PLANT MODERNIZATION AND ENLARGEMENT

Item	*K*
Machinery and Equipment including Electrical	38,13,760
Freight, Ocean and Inland	3,77,600
Buildings and Structures	8,26,000
Erection and Construction	8,82,640
Total Estimated Cost	59,00,000

A new plant at Rangoon would include a limestone quarry at Moulmein, bulk limestone barges to deliver crushed limestone to Rangoon, a simple clay pit operation at Rangoon, and a complete 60,000-long-ton-year-capacity manufacturing plant at Rangoon. The cost of this plant is shown in Table XXII–21.

TABLE XXII – 21

COSTS OF RANGOON CEMENT PLANT

Item	*K*
Moulmein Quarry Equipment	9,44,000
Clay Field Equipment	94,000
Process Machinery	70,30,000
Power Plant Equipment	11,33,000
Electrical Distribution Equipment	3,76,000
Electric Motors and Controls	4,72,000
Laboratory Equipment	71,000
Shop Equipment and Tools	5,90,000
Office and Stores Equipment	94,000
Water, Compressed Air, Sewerage and Process Pipelines, etc.	2,36,000
Sanitary and First Aid Equipment	47,000
Automotive Equipment	94,000
Barge Equipment	7,08,000
Brick and Refractories	1,42,200
Structural Steel and Doors, Roofing, etc.	13,00,000
Total Machinery and Equipment	1,33,81,200
Ocean Freight and Insurance	11,80,000
Erection and Construction Engineering	33,04,000
Foreign Specialist Expense	4,72,000
Company Overhead during Construction	2,36,000
Contingencies	10,14,800
Erected Cost less Real Estate	1,95,88,000
Real Estate	4,72,000
Total Plant Cost	2,00,60,000
Working Capital	23,60,000
Total Capital Required	2,24,20,000

These estimates are based on United States prices. Costs may be somewhat lower if the equipment and materials are purchased in Europe. Negotiations have been in progress since November, 1950, to sell a one-half interest in Burma Cement Company, Limited, to the Government of the Union of Burma. Should this proposed joint venture agreement be consummated, the most economical procedure would be to enlarge the Thayetmyo Plant.

If it is not concluded, and if the present owners are reluctant to increase the capacity of their plant now, or are not encouraged to do so, then the construction of a new plant at Rangoon should be undertaken immediately to insure an adequate supply of cement for the development program.

(h) Raw materials. A plant at Rangoon could obtain limestone from the nearest suitable limestone deposit. Shipment to the plant in company-owned barges would be the most economical means of transportation. Extensive deposits of high grade limestone

TABLE XXII – 22

ESTIMATED MANUFACTURING COST, COST OF SALES, AND PROFITS

	1	2	3	4	5	6	7	8
	Thayetmyo Plant						*Rangoon Plant*	
Item	*60,000 L.T. per Year*				*120,000 L.T. per Year*		*60,000 L.T. per Year*	
	All Gas Fuel	*Kalewa Coal*	*Imported Coal at Future Price*	*Imported Coal Present Price*	*All Natural Gas*	*Kalewa Coal*	*Imported Coal at Future Price*	*Kalewa Coal*
	K	*K*	*K*	*K*	*K*	*K*	*K*	*K*
1. Plant Cost less Fuel	32,40,000*	32,40,000	32,40,000	32,40,000	46,12,000	46,12,000	33,17,000	33,17,000
2. Fuel	1,20,000*	10,68,000	16,44,000	24,00,000	2,40,000	21,36,000	9,75,000	10,30,200
3. Total Plant Cost	33,60,000*	43,08,000	48,84,000	56,40,000	48,52,000	67,48,000	42,92,000	43,47,200
4. Admin. and Overhead	9,35,400*	9,35,400	9,35,400	9,35,400	15,45,400	15,45,400	16,96,560	16,96,560
5. Cost of Sales	42,95,400*	52,43,400	58,19,400	65,75,400	63,97,400	82,93,400	59,88,560	60,43,760
6. Gross Sales	1,05,00,000*	1,05,00,000	1,05,00,000	1,05,00,000	2,10,00,000	2,10,00,000	1,05,00,000	1,05,00,000
7. Less Freight absorbed and Handling (IWT)	24,90,000†	24,90,000†	24,90,000†	24,90,000†	49,80,000‡	49,80,000‡	—	—
8. Net Sales	80,10,000*	80,10,000	80,10,000	80,10,000	1,60,20,000	1,60,20,000	1,05,00,000	1,05,00,000
9. Less Cost of Sales (5)	42,95,400*	52,43,400	58,19,400	65,75,400	63,97,400	82,93,400	59,88,560	60,43,760
10. Gross Profit	37,14,600*	27,66,600	21,90,600	14,34,600	96,22,600	77,26,600	45,11,440	44,56,240
11. Less Taxes at 50%	18,57,300	13,83,300	10,95,300	7,17,300	48,11,300	38,63,300	22,55,720	22,28,120
12. Net Profit	18,57,300	13,83,300	10,95,300	7,17,300	48,11,300	38,63,300	22,56,720	22,28,120
13. Capital Investment	75,00,000	85,00,000	85,00,000	85,00,000	1,27,50,500	1,27,50,500	2,24,20,000	2,24,20,000
14. Percentage Return on Investment	24·7	16·25	12·9	8·45	37·7	31·5	10·50	9·90

* Furnished by Burma Cement Company, Limited.
† This could be reduced to K 7,21,350 if Rangoon cement is transported in company barges.
‡ This could be reduced to K 14,42,700 if Rangoon cement is transported in company barges.

are known to exist in the Moulmein district. One large deposit covering 16 square miles is located across the Salween River north of Moulmein. This deposit touches a deep water channel, and while the depth is not known, the volume of limestone in this deposit appears to be adequate to supply the plant for many years.

The average analysis of the limestone in this area has been determined to be 80·0% $CaCO_3$, while the best, from the Nydone quarter, tests 98·0%. This is 30–35 miles from Moulmein.

Local clays are available in the Rangoon area. Clays used for the manufacture of building-brick are usually satisfactory for use in the manufacture of Portland cement, as they contain the necessary silica and alumina. About 19,200 long tons per year will be required. Gypsum, required as a retarder for controlling the setting time, may be either imported or obtained from sources above Thayetmyo, on the Irrawaddy River.

(i) **Manufacturing cost.** To present fully the economics of either building a new plant at Rangoon, or doubling the capacity of the Thayetmyo plant, and of operating each plant with different fuels, cost estimates for each plant have been prepared as shown on Table XXII–22.

All Thayetmyo plant estimates are based upon the present I.W.T.B. water freight rates for Rangoon shipments, as well as the Rangoon handling and warehouse costs. The estimated net profits determined for each condition are shown, ranked in the order of least earnings, in Table XXII–23.

TABLE XXII – 23

ESTIMATED CEMENT PROFITS

(Ranked in order of least return)

	K
Thayetmyo at 60,000 L.T.—Present Price Imported Coal	7,17,300
" " " " —Future " " "	10,95,300
" " " " —Kalewa Coal	13,83,300
" " " " —Natural Gas	18,57,300
Rangoon " " " —Kalewa Coal	22,28,120
" " " " —Future Price Imported Coal	22,55,720
Thayetmyo at 120,000 " —Kalewa Coal	38,63,300
" " " " —Natural Gas	48,11,300

It is doubtful at this time that enough additional gas can be found at Thayetmyo to support the operation of the plant if the capacity is doubled. It would be safer to assume that all gas would be reserved for power generation, and that Kalewa coal would be used for process purposes. If this assumption is correct, a new plant at Rangoon and the operation of the Thayetmyo plant at its present capacity using natural gas would provide the most advantageous arrangement as is shown in Table XXII–24.

TABLE XXII – 24

BEST COMBINATION

Capacity L.T.	*Fuel*	*Annual Net Profit*
Thayetmyo—60,000 Rangoon—60,000	Natural Gas Future Price Imported Coal	K18,57,300 K22,55,720
120,000	Total	K41,13,020
Thayetmyo—120,000	Kalewa Coal	K38,63,300

However, this would not provide the most favorable return on the investment due to the greater cost of building the Rangoon plant. These would compare 31·5% for Thayetmyo against 13·75% for the two-plant combination.

At any rate, it is clear from the estimates that a 60,000-long-ton-capacity plant at Rangoon could manufacture and sell cement in Rangoon at a price below the Thayetmyo plant if the latter is not enlarged. From the estimates, the Rangoon plant could make the same gross profit, when selling at a price of K153.98 per long ton, as the Thayetmyo plant (using cheap natural gas) can when selling at the present Rangoon price of K168.00 per long ton.

This competitive advantage of the Rangoon plant will only survive as long as shipments are made to Rangoon via the IWTB barges at present freight rates, which are extraordinarily high. A plant at Rangoon could therefore establish and hold a favorable competitive position against other cement. This position could be made even more secure by selling as much as possible of its cement in bulk and thus eliminating the cost of paper sacks and Rangoon unloading and warehousing costs, amounting to K22.73 per long ton in total.

Such a plant is economically sound, even though the return on the investment would be less than on the present plant at Thayetmyo, due solely to its greater construction cost. Its construction should therefore depend upon the outcome of the negotiations to purchase a one-half interest in Burma Cement Company, Limited. The Portland cement situation is discussed further in Project No. 38.

(j) Other products. A new plant at Rangoon could earn additional profits from the production and sale of lime and limestone products. It was shown in the discussion of Limestone Products, Project No. 27 (b) and (c), that a large market for railway ballast, highway metal and concrete aggregates exists in the Rangoon area. The coarse concrete aggregate requirements alone were estimated to be 216,000 long tons per year.

If these requirements were supplied by the new cement mill at Rangoon from its quarries near Moulmein, the cost of production and of transportation to Rangoon would be greatly reduced.

In Project No. 29, Lime, it is shown that there is a need for quicklime and hydrated lime in the Rangoon area. Quicklime may be manufactured in a Portland cement kiln, whenever the kiln was not required for producing cement clinker. A small additional investment would be required to equip this plant for such dual purposes. Quicklime and hydrated lime cost much less to manufacture than Portland cement, though the current price in Rangoon is very little below that of imported cement.

If the Rangoon plant is built in the near future, the market may not absorb all of its capacity during the early years of operation. Consequently, the manufacture of quicklime would aid in supporting the project until a market for the full output of cement develops.

(29) Lime

(a) Historical. Lime for plaster is widely used in Burma for both interior and exterior purposes in building construction. In fact almost all public buildings are of this type and most pucca buildings are of this design. Such plasters are normally applied over common red brick walls. Thus large quantities of lime are required for mortar too.

The large-scale building program resulting from the execution of the Economic and Industrial Development Program will greatly increase the demand for and use of this product for housing, industrial buildings and public structures.

GUB import records do not reveal any imports of either quicklime or of hydrated lime. It is therefore safe to assume that all lime used is produced domestically. However, no statistics are available covering the quantities made or used.

(b) Market estimates. In the United States, about three tons of Portland cement are sold for each ton of lime. In Burma the use of Portland cement per capita is one of the lowest in the world. However, the almost universal use of lime for plaster on most permanent buildings in Burma, and the equally universal use of brick for walls, which requires mortar, should alter the ratio for Burma.

It is therefore estimated that the lime used in Burma would be more nearly on a 2 to 1 ratio with Portland cement use. If so, then the present annual use of lime in Burma would be approximately 35,000 tons per year.

It has been estimated that the use of Portland cement in Burma will double in the next ten years. The demand for lime should increase proportionately, so that the market should absorb approximately 70,000 long tons per year. These estimates are considered to be conservative, as most countries are increasing their use of cement (and presumably of lime), at a much faster rate than is estimated for Burma.

On the basis of the estimated present use of lime, about 120 long tons per day are needed. A modern lime plant of this capacity is an economic size, well able to produce high grade quicklime and hydrated lime at low cost.

From 75% to 82·5% of all cement sales in Burma are made in the Rangoon area. There is every reason to believe that lime sales would follow the same pattern, as Rangoon has a greater percentage of permanent type buildings than any other city in Burma. On the basis of 80% use in Rangoon, this market will now absorb about 28,000 long tons of lime per year, which should increase to 56,000 long tons by the end of ten years.

A lime plant having an initial capacity to produce 100 long tons per day would be a proper size for consideration, as it would handle all of the current Rangoon requirements.

(c) **Present source.** At present all lime used in the Rangoon market is made in the Moulmein district where abundant deposits of high grade limestone are known to exist. The extent of these has been reported in Project No. 28, Portland Cement. No modern lime plants exist in this area and much is made on a small scale, almost on a cottage industry scale. Much of the lime produced is not well burned and its quality is therefore very inferior.

None is packed in paper bags, but in jute bags or used tin containers. Most quicklime is shipped to Rangoon in jute bags containing about 76·5 pounds. The hydrated lime inspected is usually sold in four-gallon kerosene tins containing from 30 to 35 pounds, net weight.

The current dealer price in Rangoon is K140.00 per long ton for quicklime, and K146.41 for hydrated lime, in the above containers.

(d) **Plant location.** To supply the Rangoon market area a lime plant could be located either in Rangoon or in Moulmein. The choice of location is dependent upon the relative costs of handling and transporting the raw limestone and fuel to the major market at Rangoon, and the cost of transporting fuel to Moulmein and the finished product to Rangoon.

In the manufacture of lime, limestone is calcined in a kiln. A high grade limestone is converted from calcium carbonate ($CaCO_3$) to calcium oxide (CaO), in the kiln. There is a considerable loss of weight in this process, the loss being principally CO_2 (carbon dioxide) gas. To make one ton of quicklime, approximately two tons of limestone are required.

If the plant is located at the limestone deposit, only one half as much material must be moved to market if only quicklime is sold. Normally, however, bulk raw materials may be transported cheaper than finished products due to the fact that they can be handled more easily by mechanical methods. And, as there is a large market in the Rangoon area for railway ballast, highway metal and concrete aggregate, these requirements can best be supplied from Moulmein. The advantages of producing and selling these limestone products in Rangoon outweigh the advantages of producing quicklime at the quarry site, and the equipment for moving these products in bulk would be operated cheaper on the larger volume basis.

Fuel oil, which is the preferred fuel for producing lime, can be delivered cheaper in Rangoon than in Moulmein. Labor is available in Rangoon, as is power. It is therefore recommended that the lime plant be located in the Rangoon industrial district, on a site on the east bank of the Rangoon River and near a railroad line.

(e) **Cost of plant.** A 110-long-ton-per-day capacity lime plant would cost:

Item	*K*
Moulmein Quarry and Crushing Plant	4,72,000
Barge Equipment	4,72,000
Process Machinery	18,88,000
Electrical Distribution—Motors—Controls	4,72,000
Laboratory Equipment	75,000
Shop Equipment and Tools	4,00,000
Office and Stores Equipment	94,000
Water, Compressed Air, Sewerage, Process Pipelines	2,00,000
Fuel Oil Storage and Handling	3,00,000
Sanitary and First Aid Equipment	50,000
Automotive Equipment	94,000
Brick and Refractions	1,00,000
Structural Steel, Roofing, etc.	7,08,000
Total Machinery and Equipment	53,25,000
Ocean Freight and Insurance	6,00,000
Erection and Construction including Engineering	12,50,000
Foreign Specialist Expense	4,72,000
Company Overhead during Construction	2,36,000
Contingencies	3,84,000
Actual Cost less Real Estate	82,67,000
Real Estate	4,13,000
Total Plant Cost	86,80,000
Working Capital	18,88,000
Total Capital Required	1,05,68,000

The total estimated cost may be divided between foreign exchange and local currency, as follows:

Foreign Exchange (Kyats equivalent)	K79,43,000
Local Currency	K26,25,000
Total	K1,05,68,000

(f) Construction schedule. It is estimated that it will require two years to place this plant in operation, dating from the time consulting engineers are retained. The expense during the first year would consist of a preliminary survey and report, of engineering drawing preparations, quarry and plant site acquisition and grading, some foundation construction work, and of advance payments for machinery, equipment and material. These are estimated to total K42,00,000 for the first year. This may be divided between foreign exchange and local currency, as follows:

Foreign Exchange	K30,00,000
Local Currency	K12,00,000
	K42,00,000

(g) Manufacturing cost, cost of sales, and profits. It is assumed that one half of the production of the plant will be quicklime, and one half hydrated lime. For each ton of hydrated lime produced, 0·756 tons of quicklime will be required. Thus the daily production would be 50 long tons quicklime, and 66 long tons hydrated lime, or 116 long tons per day. Limestone is estimated to cost K20.00 delivered in Rangoon. Two hundred long tons per day would cost K4,000. Operating 300 days per year, the annual cost would be K12,00,000.

About 1·1 United States barrels of Bunker C fuel oil will be required per long ton of quicklime. At a production rate of 100 long tons of quicklime per day, 110 United States barrels of fuel will be required, or 33,000 per year. This is equivalent to 1,154,000 imperial gallons. At a price of K0.6 per imperial gallon, the annual fuel cost would be K6,92,400.

The estimated manufacturing cost, cost of sales, and profits, are as follows:

QUICKLIME

Item	*Cost per Year (Kyats)*	*Cost per Long Ton (Kyats)*
Operating and Repair Labor	1,00,000	—
Operating and Repair Supplies	50,000	—
Limestone	12,00,000	—
Fuel Oil	6,92,400	—
Power	1,06,200	—
General Works Expense	1,00,000	—
Amortization of Loan	6,00,000	—
Insurance	50,000	—
	28,98,600	96.62

HYDRATED LIME

Item	*Cost per Year (Kyats)*	*Cost per Long Ton (Kyats)*
Quicklime	14,49,300	
Operating and Repair Labor	50,000	
Operating and Repair Supplies	25,000	
Power	2,12,400	
General Works Expense	75,000	
Amortization of Loan	2,30,495	
Insurance	25,000	
	20,67,195	104.39

Paper sacks and packing costs will increase the unit costs per ton by approximately K16.00, making the ex-warehouse costs K112.62 per long ton for quicklime and K120.39 per long ton for hydrated lime.

At present prices, the following gross profit would result:

15,000 L.T. Quicklime at K140.00	K21,00,000
19,800 L.T. Hydrated Lime at K146.41	K28,98,918
Gross Income	K49,98,918
Cost of Sales:	
15,000 L.T. Quicklime	K16,89,300
19,800 L.T. Hydrated Lime	K23,83,722
	K40,73,022
Gross Profit per Year	K9,25,896
Per cent Return on Investment	8·75

Spreading the amortization costs over 25 years instead of 20 years would reduce the annual payments by K98,915, which would reduce the average cost per long ton by K2.84.

(h) Recommendations. Because the anticipated need for lime will increase rapidly as the development program gets under way, because lime manufactured in a modern plant will be superior in quality and thus more valuable per ton, because it can be made profitably in Rangoon, and because the construction of such a plant meets every requirement of the development program, a plant of this type should be built in Burma.

There would be definite savings in both investment and manufacturing costs if lime were manufactured as a division of a Portland cement plant. Therefore this should be carefully investigated before an independent plant is built, even though the latter can be justified alone.

(30) Asbestos Cement Products

(a) Introduction. The Economic and Industrial Development Program will substantially increase the demand for all types of building construction materials. Asbestos cement roofing, siding, and interior wall and ceiling sheets, are among the building materials for which the demand is rapidly increasing.

All pipe now used in Burma is imported. Although a steel products plant is proposed, it is not planned to include the manufacture of cast iron or steel pipe. No clay or concrete pipe is presently being manufactured in Burma. Excellent pressure pipe can be made in a relatively simple plant from asbestos and Portland cement. This pipe is manufactured in four classes, corresponding to working pressures of 50, 100, 150 and 200 pounds per square inch. It resists corrosion much better than metal pipe. Asbestos cement sewer pipe and ducts are also in common use.

(b) The **market.** The market for asbestos cement sheets in Burma is increasing at a rapid rate. The import records show this clearly.

IMPORTS OF ASBESTOS CEMENT SHEET PRODUCTS

Fiscal Year	*Long Tons*
1937–38	1,028
1938–39	895
1939–40	1,207
1940–41	1,030
Prewar average	1,040
1945–46	—
1946–47	1,639
1947–48	2,768
1948–49	1,283
1949–50	326
1950–51	2,196
1951–52	6,514
1952–53*	6,771*
Postwar average	2,454

*First eight months only.

Approximately 240,000 new houses of the non-basha type will be built in Burma during the next ten years. If these use an average of only 2,000 sq. ft. of roofing each, the total square feet of laid roofing required will be 480,000,000.

The three fire-resistant types of roofing used in Burma are clay tile, asbestos cement and metal. If only one fourth of this roofing is to be corrugated asbestos cement, 120,000,000 sq. ft. of laid roofing of this type will be required. Without considering any overlaps, this would be equivalent to 139,285 long tons. An average per year would be 13,928 long tons. This would be over 200% of the 1951–52 imports. This estimate does not include corrugated roofing for factory or warehouse buildings, corrugated siding or flat sheets. It is estimated that the demand would increase the total to 29,000 long tons per year. The requirements for water, sewer, and other pipe and conduit are estimated to be in excess of 6,000 tons per year.

It should be possible to reduce the selling price if and when asbestos cement sheets are manufactured in Burma, which will stimulate sales and use. Asbestos cement pipe should be produced and sold at prices below metal pipe, which will increase its use.

(c) **Plant location.** There are only two feasible locations for an asbestos cement products plant; at Thayetmyo, where Portland cement is produced, and at Rangoon, where the imported asbestos will be received. Rangoon is the major market for all building materials, and is the distribution point for commodities to all parts of Burma by water, rail, highway and air.

If manufactured at Thayetmyo the imported asbestos would be transported by water to the plant, and about 75% of the finished products would have to be shipped back to Rangoon. At prevailing freight rates this would be uneconomic. Portland cement could be supplied in bulk, thus eliminating the packing cost and cost of paper bags. However, the pricing policies of the cement company prohibit the manufacture of asbestos cement products at Thayetmyo, as the selling price of Portland cement made and sold at Thayetmyo is K192.00 per long ton compared to K168.00 in Rangoon.

The lower cost of each raw material in Rangoon, and the elimination of extra transportation charges on both raw materials and finished products, favor a Rangoon location.

Because all raw materials will be delivered to the plant by water, and because much of the finished product will move from the plant by water transport, the plant should be located on the east bank of the Rangoon or Hlaing River. Rail and highway connections will be required. A suitable site may be found in the Insein industrial district, either above or below the village of Kamayut.

(d) **The proposed plant.** After studying the present and estimated future market demand for asbestos cement products, it is recommended that a combination sheet and pressure pipe plant be erected. Many economies will result if the two plants are contiguous and under one ownership and management.

Non-pressure pipe can be manufactured cheaper as concrete pipe without asbestos. Therefore it is recommended that a separate division for manufacturing such pipe for drain and sewer use be added to the asbestos cement plant. The initial capacity of an asbestos cement sheet plant should be 700 long tons per month, or 8,400 long tons per year, which would require a two-machine plant. Additional units can easily be added as required to meet expanding demands. The initial capacity of the asbestos cement pipe plant should be 550 long tons per month. This would provide 6,000 long tons per year, net. The non-pressure concrete pipe plant should have an initial capacity of 50 six-foot lengths per day, or 300 lineal feet total, of various diameters. This would be an annual capacity of 90,000 lineal feet. It is proposed to operate each plant 300 days per year to obtain the rated capacities of each division.

The three divisions would be designed around a central cement, asbestos and aggregate storage plant that would serve all three units. The asbestos storage must be of large enough capacity to receive and store shipload consignments of this product, in several grades. Each unit requires large storage and curing areas. The cement storage may be smaller as this material may be obtained in Burma.

(e) Investment cost. The cost of each unit in the proposed three-unit plant is estimated as shown in Table XXII–25.

TABLE XXII – 25

COSTS FOR A THREE-UNIT ASBESTOS CEMENT AND CONCRETE PIPE PLANT

Item	*Estimated Cost—Kyats*		
	Asbestos Cement		*Concrete Pipe Plant*
	Sheet Plant	*Pressure Pipe Plant*	
Pan Mill and Disintegrator	21,700	21,700	—
Conveyors, Blower, Storage and Bagging Bin, Scale and Vibrator	9,300	9,300	—
2 Sheet Machine Units	10,07,500	—	—
Pressure Pipe Unit	—	6,97,500	—
Spun Concrete Pipe Equipment	—	—	3,48,750
Machinery and Electrical Equipment	10,38,500	7,28,500	3,48,750
Ocean Freight, Insurance, Buildings, Engineering, Erection and Training	8,30,800	5,82,800	1,74,375*
Erected Cost Less Property	18,69,300	13,11,300	5,23,125
Real Estate	77,500	77,500	31,000
Total Plant Cost	19,46,800	13,88,800	5,54,125
Working Capital	9,30,000	6,20,000	1,55,000
	Three-plant Total		55,94,725

*No buildings required.

The total capital required may be divided into foreign exchange and local currency, as follows:

	Foreign Exchange *K*	*Local Currency* *K*
Asbestos Cement Sheet Plant	13,48,500	15,28,300
Asbestos Cement Pressure Pipe Plant	9,30,000	10,78,800
Spun Concrete Pipe Plant	3,87,500	3,21,625
	26,66,000	29,28,725

(f) Construction and expenditure schedule. The asbestos cement units will require the following time for completion. (1) To manufacture machinery, construct buildings in Rangoon, and train key operators abroad, ten months. (2) To install machinery, six months. (3) Commissioning period, three to six months.

Total time, 19–22 months.

The spun concrete pipe unit could be erected in less time, but for practical purposes will be considered as requiring the same time as the other units. All time estimates are based upon the date that contracts are signed for engineering work.

The expenditures for the first year will be principally for acquisition of real estate, grading plant site, dock construction; foundations, engineering work, machinery, equipment and material. These expenditures for the first year would total, for the three units, about as follows:

	Foreign Exchange *K*	*Local Currency* *K*
Asbestos Cement Sheet Plant	11,00,000	6,00,000
Asbestos Cement Pressure Pipe Plant	8,00,000	4,00,000
Spun Concrete Pipe Plant	2,75,000	1,25,000
	21,75,000	11,25,000

(g) Financing of project. A project of this type may be financed and owned in any one of three ways. One would be a 100% private ownership by either national or foreign interests. A second method would be a joint venture operation with the Government of Burma participating in the equity ownership on an agreed basis with the balance in the hands of national or foreign private interests, and with the management responsibility in the hands of the private interests. The third method would be a 100% equity ownership by the Government of Burma.

A method of financing by the Government of Burma would consist of the GUB extending a 100% capital loan to a wholly GUB-owned corporation formed for the purpose of building, operating and managing these enterprises. The loan would be secured by the assets of this corporation.

The loan would bear compound interest at the rate of 5% for all foreign capital loaned, and at the rate of 4% for all local currency advanced. The loan would be repaid out of earnings, in equal annual payments, made over a period of years corresponding to the useful life of the machinery, equipment and buildings. A weighted average useful life of 20 years has been assumed. The annual payments on each unit, to fully recover 100% of the capital loan, with compound interest at the rates above, in 20 years, are calculated as follows:

	Amount (K)	*Factor*	*Annual Financial Cost (K)*
Asbestos Cement Sheets			
Foreign Exchange	13,48,500	·08204	1,08,203
Local Currency	15,28,300	·07358	1,02,452
Total	28,76,800	—	2,10,655
Asbestos Cement Pressure Pipe			
Foreign Exchange	9,30,000	·08204	74,623
Local Currency	10,78,800	·07358	79,377
Total	20,08,800	—	1,54,000
Spun Concrete Pipe			
Foreign Exchange	3,87,500	·08204	28,093
Local Currency	3,21,625	·07358	23,662
Total	7,09,125	—	51,755

The foregoing annual financing costs would be charged into the unit cost of each product, based upon the total volume of production of each. No depreciation, as such, will be assessed against manufacturing costs in a corporation financed in this manner. Therefore, no capital recovery reserve will be maintained. Any additional capital required will be obtained in the same manner as the original capital, and will be repaid in the same manner. Such a wholly GUB-owned corporation would presumably operate on a non-profit basis, and would be exempt from import duties and taxes.

From investigations made, it is certain that private capital in Burma is able and willing to invest in these enterprises, either on a 100% private basis, or upon a joint venture basis with the Government of the Union of Burma. If these interests are encouraged to undertake these projects on either basis, other methods of financing would probably be used. The estimated gross profits would be slightly lower because duty

TABLE XXII – 26

ESTIMATED COST OF SALES AND GROSS PROFITS FOR ASBESTOS CEMENT SHEET AND PRESSURE PIPE PLANT

	Sheet Plant		*Pressure Pipe Plant*		*Spun Pipe Plant*	
	Annual Cost	*Cost per Long Ton*	*Annual Cost*	*Cost per Long Ton*	*Annual Cost*	*Cost per Lin. Ft.*
	K	*K*	*K*	*K*	*K*	*K*
1. Operating Labor	2,18,400	—	40,500	—	33,600	—
2. Operating and Repair Supplies and Labor	1,08,000	—	1,62,000	—	10,000	—
3. Asbestos Fiber	7,98,000	—	12,90,000	—	5,000*	—
4. Portland Cement	9,24,000	—	7,92,000	—	22,000	—
5. Power	72,000	—	48,000	—	12,000	—
6. Water	6,000	—	3,600	—	500	—
7. General Works Expense	36,000	—	12,000	—	6,000	—
8. Administrative Expense	54,000	—	18,000	—	12,000	—
9. Insurance and Local Taxes	24,000	—	12,000	—	5,000	—
10. Amortization of Capital Loan	2,10,650	—	1,54,000	—	51,755	—
11. Sand	—	—	—	—	} 30,000	—
12. Aggregate	—	—	—	—		
13. Total	24,51,050	291.79	25,32,100	422.01	1,87,855	2.08
14. Allowance for Manufacturing Breakage	2,45,100	29.18	2,53,200	42.20	18,785	0.21
15. Cost of Sales Ex-Warehouse	26,96,150	320.97	27,85,300	464.21	2,06,640	2.29
16. C.I.F. Cost	35,95,200	428.00	31,62,000	527.00	2,33,000†	2.59
17. Breakage Allowance	1,79,760	21.40	3,16,200	52.70	23,000	0.26
18. Gross C.I.F. Cost	37,74,960	449.40	34,78,200	579.70	2,56,000	2.85
19. Port Charges, Stevedoring—Warehousing	3,01,990	35.95	2,78,250	46.38	21,555	0.23
20. Gross Cost Ex-Warehouse	40,76,950	485.35	37,56,450	626.08	2,77,555	3.08
21. Less Cost of Sales	26,96,150	320.97	27,85,300	464.21	2,06,640	2.29
22. Gross Profit or Saving	13,80,800	164.38	9,71,150	161.87	70,915	0.79
23. Capital Investment	28,76,800	—	20,08,800	—	7,09,125	—
24. Per cent Return on Investment	48·0	—	48·4	—	10·0	—
25. Consolidated Investment	—	—	—	—	55,94,725	—
26. Per cent Return	—	—	—	—	40·8	—

* Wire. † Estimated, none imported.

would have to be paid on all imported materials and because taxes would be assessed. Such an arrangement offers the advantage of experienced management.

(h) Manufacturing cost—cost of sales and profit. The manufacturing costs, cost of sales, and profit, for a wholly owned GUB corporation, as estimated, are shown in Table XXII-26. The estimated costs are based upon current prices of raw materials, or upon estimated prices. Asbestos would have to be imported. Several grades are required for the sheets and for the pressure pipe. The basic unit in the sheet plant is the three sixteenth inch flat sheet. These require

11·6 pounds of Portland cement per square yard,
1·8 pounds of asbestos fiber per square yard,

13·4 pounds material, plus water.

The sheet weighs 15·75 pounds per square yard, dry weight.

Asbestos of lower quality (shorter fiber) is used in the manufacture of sheets. A normal mixture of the grades required would cost K972.16 per long ton c.i.f. Rangoon. The better grade required for the pressure pipe would have an average value of K1,770.72 per long ton, c.i.f. Rangoon. The cement asbestos ratios vary in the flat and corrugated sheets, being about 8:1 by weight for the flat sheets, and 6·4:1 for the corrugated. A considerable allowance for breakage must be made in the manufacturing cost estimates.

From these estimated figures it is clear that each of the products could be manufactured in Burma at a low cost and that they could be sold at a good profit at prices much lower than for the same imported products. If the Portland cement can be purchased in bulk, considerable reductions in cost would result.

A volume-based price discount could probably be arranged with the cement manufacturer, as the combined use of Portland cement in the three plants would total over 10,000 long tons per year. This amount represents 16·67% of the capacity of the existing plant at Thayetmyo. The initial plants will not supply all of the estimated requirements of Burma for asbestos cement products. If enlarged to do this, the cement purchases would double. If they did reach the total of 20,000 long tons per year, these plants would absorb one third of the new cement manufacturing capacity that has been recommended in the reports on Projects 28 and 38. This is an example of how a single new industry can affect the business of another supporting industry.

(i) Economies of importing. Should the asbestos cement sheets and pipe be imported instead of manufactured in Burma, and should the use be as estimated, the foreign exchange required over a ten-year period would be as follows, based upon present prices.

Sheets:	K
290,100 L.T. × K428.00 (c.i.f.)	12,41,62,800
Pipe:	
62,680 L.T. × K527.00 (c.i.f.)	3,30,32,360
Total	15,71,95,160
Less Asbestos Imported:	
290,100 L.T. × K95.00 (Sheets)	2,75,59,500
62,680 L.T. × K215.00 (Pipe)	1,34,76,200
Total	4,10,35,700
Net Foreign Exchange for Material	11,61,59,460
Less Plant Machinery	26,66,000
Net Saving in Foreign Exchange	11,34,93,460

The three plants will (at the initial capacities) create many new jobs. The annual labor payrolls alone are estimated to total K4,32,500. About 300 men will be employed. The production of the three plants will have an annual total value of K81,10,955. This addition to the national income, K8,11,09,550 for ten years, approximates 70% of the foreign exchange saved over imports. This foreign exchange can be released for other purposes that will add to the health and living standards of the people.

The estimated gross profit, if applied to reducing the selling price of these asbestos cement products, will increase the purchasing power of the people, and release income for other purposes.

(j) Conclusions and recommendations. There is a growing demand for these imported products which can be manufactured in Burma and sold at a fair profit at prices well below the ex-warehouse prices of similar imported commodities. The products increase the life and reduce the fire hazard of any structure in which they are used.

The foreign exchange released will be an important help in increasing the living standards of the people, and steady employment of many people at manufacturing wage scales will contribute to the stability of the Union and to its national income. Operation of these plants will also provide secondary employment in other supporting industries and services, such as Portland cement and transportation.

As all of the products to be manufactured will be needed in carrying out the industrial development program, and as these plants are of the basic type that is desired to make this development plan successful, it is strongly recommended that they be approved and steps taken for immediate implementation.

(31) Steel Products Plant

(a) **Introduction.** At present there are no facilities for the manufacture of steel or of steel products in the Union of Burma. It is necessary to import them. Ocean freight, insurance, port charges and duty must be included in the delivered cost of these commodities. Consequently the resulting selling price is higher than in countries where such products are manufactured. High selling prices restrict the use of steel products. Nevertheless, 40,000 tons are being imported annually. A large block of foreign exchange must therefore be allocated each year to cover the cost of purchasing and delivering them to this country.

The quantity of steel products imported annually is sufficient to warrant the establishment of a national steel industry if suitable raw materials are available. As the Government of the Union of Burma is taking steps to make this country as industrially independent as possible, and is implementing a comprehensive program of economic and industrial development to carry out this objective, the establishment of such a basic national industry is a logical part of such a plan. One purpose of this Report is to explore the economics of establishing a steel products plant in Burma.

(b) The **market.** The five-year average of prewar imports of all steel products into Burma was approximately 70,000 long tons per year. While the postwar average is below this figure, it is believed that the total use will be approximately double the prewar average use by the end of the next ten-year period.

As will be discussed later, any steel produced in Burma, at least initially, must be made entirely from steel scrap available or to be generated in Burma, or from imported steel scrap or billets.

A steel products plant should be planned to produce only selected steel commodities because the rate at which steel scrap is generated would not support a mill of capacity great enough to meet all needs, and because a plant equipped to manufacture all of the types and sizes required would be too elaborate and expensive. Only the lighter steel products should be manufactured. These should consist of light shapes, bars, rods, sheets, and such wire products as black and galvanized wire, barbed wire, nails, screws, nuts and rivets.

An examination of the imports of light steel products 1936–37 to 1940–41 average reveals the following:

Bars and Flats and Reinforcing Steel	5,300	long	tons
Wire Nails	4,120	,,	,,
Rivets, Washers, etc.	1,350	,,	,,
Bolts and Nuts	770	,,	,,
Wood and Metal Screws	450	,,	,,
Wire other than Fencing	950	,,	,,
Fencing Material including Wire	410	long	tons
Hoops and Strips	690	,,	,,
Small Structural Shapes	1,000	,,	,,
Plates and Sheets—Black, Galvanized and Tinned	19,000	,,	,,
Total	34,080	,,	,,

(c) **Plant capacity.** To supply the present minimum market demand for light steel products the plant should have a capacity of from 30,000 to 35,000 long tons per year. This capacity would leave no room for an increase in demand resulting from a normal growth. To meet the increasing demand a plant of 40,000 to 50,000 tons annual capacity could be justified. However, the necessary domestic raw materials are not sufficient to support this production rate, consequently the capacity must be limited by available raw materials.

The Ministry of Industries made a preliminary study of the proposed steel products plant, and as a result, on July 9, 1952, issued invitations for tenders for the machinery, equipment and erection of a complete plant to manufacture the following steel products:

Product	*Long Tons*	*Long Tons*
Angles from ¾″×¾″×⅛″ to 3″×6″×½″	575	
Channels from 2″×4″ to 3″×6″	100	
H Beams from 4″×1¾″ to 5″×3″	30	
T Beams from 1½″×1½″×¼″ to 4″×4″×½″	100	
Flats from ½″×1″ to 1″×4″	1,030	
Rounds from 3/16″ to 4″	2,000	
Squares from ¼″ to 3″	156	
Total Shapes and Bars		3,991
Bolts and Nuts from ¼″ to 1″	1,250	
Rivets from ¼″ to 1″	350	
Wood Screws from ½″ 6gg to 3″ 12gg	275	
Total Hot and Cold Process Products		1,875
Wire Nails	4,165	
Barbed Wire	150	
Galvanized Steel Wire 4–22gg	112	
		4,427
Flat Galvanized Sheets—		
24gg×3′×(6′–7′–8′–9′–10′)	1,400	
22gg×3′×(6′–7′–8′)	1,500	
Corrugated Galvanized Sheets—		
22gg×2′–8′×10/3×(6′–7′–8′–9′–10′)	2,600	
Total Sheets		5,500
Plates, 1/16″ to 1″		300
Railway Materials		410
Hoop Iron		600
Total Annual Minimum Production		17,103

Note: A further 5,000–10,000 tons of sheets for private consumption was noted as an additional goal.

It was also specified that the products listed be produced in a plant using 16,000 long tons of scrap and

4,000 tons of railroad rails which were to be re-rolled but not re-melted. Several other studies have been made to determine the size of the plant. All of these, considering availability of steel scrap and variety of steel products used, indicate that the proposed plant should have a capacity of about 20,000 long tons per year. By eliminating all sheet and plate manufacture, the plant could produce all of Burma's present demands for wire, rod, and light shapes. This would total about 15,000 long tons per year. However, more than 50% of Burma's use of light steel products are light sheets, black galvanized, flat and corrugated. The manufacture of such products should be included in the plant.

If the plant is built to a capacity of 15,000 long tons it will cost very little less than a 20,000-ton plant. The size of the equipment would be about the same in either case, as the size is determined partially by the ability of the equipment to reduce billets and slabs of a practical and standard size to smaller sections. If the plant is constructed initially for 15,000 tons annual capacity and if it becomes necessary to enlarge it later, the installation of parallel units of 5,000 or 10,000 tons capacity would be impractical because these units could not handle the same ingots and slabs as would the original and larger units. The result would be that the original equipment would have to be duplicated at a much greater cost than installing 20,000-ton equipment originally.

The proposed plant would, in fact, have a capacity in excess of 20,000 long tons per year, because it is to be planned for a 16-hour-per-day, 300-day-per-year

TABLE XXII – 27

SUMMARY OF ESTIMATED TONNAGES, ACTUAL AND POTENTIAL, OF IRON AND STEEL SCRAP IN BURMA

Source or Location	*Actual Tonnage Known*			*Potential Tonnage*			*Total*	*Remarks*
	Carbon Steel and WI	*Alloy*	*Cast Iron*	*Carbon Steel and WI*	*Alloy*	*Cast Iron*		
Burma Railways	35,820	—	—	—	—	—	35,820	
Road Bridges	2,045	—	—	—	—	—	2,045	*Actual Carbon Steel* 80% *1st* Quality Scrap 18% *2nd* Quality Scrap 2% Under ⅛ in. thick
River Craft	—	—	—	5,000	—	—	5,000	
Ledo Road	—	—	—	17 500	—	—	17,500	
Tamu Road	—	—	—	12,000	—	—	12,000	
Mandalay	—	—	—	1,100	—	100	1,200	
Myitkyina	1,400	—	350	200	—	—	1,950	
Sahma	300	—	—	—	—	—	300	*Potential Carbon Steel* 50% *1st* Quality Scrap 45% *2nd* Quality Scrap 5% under ⅛ in. thick
Prome	—	1,400	—	—	—	—	1,400	
Akyab	2,000	—	100	—	—	—	2,100	
Kyaukpyu	2,925	250	100	—	—	—	3,275	
Chauk	5,000	—	—	—	—	—	5,000	
Yenangyaung	5,000	—	—	—	—	—	5,000	
Lanywa	500	—	—	—	—	—	500	To assess these percentages accurately, scrap must be collected and sorted
Meiktila	220	60	—	—	—	—	280	
BOC, Syriam	8,000	—	2,000	—	—	—	10,000	
Tank Farms, Seikkyi	5,000	—	—	—	—	—	5,000	
Rangoon								
Tram Rails	—	—	—	4,000	—	—	4,000	*Note:* Heavy steel scrap not less than ¼ in. thick is *1st* Quality. Medium steel scrap not less than ⅛ in. thick is *2nd* Quality
Port Area	200	500	—	—	—	—	700	
Montgomery St. and Thompson St.	—	—	—	8,000	—	2,000	10,000	
Monkey Point	650	—	100	—	—	—	750	
Shwedagon Pagoda	2,750	—	250	—	—	—	3,000	
Windermere Park	450	—	100	—	—	—	550	
Slaughter House	100	—	200	—	—	—	300	
Mingaladon	—	750	—	—	—	—	750	
Miscellaneous sources in Rangoon	—	—	—	1,000	—	250	1,250	
	72,360	2,960	3,200	48,800	—	2,350	129,670	
Undiscovered sources	—	—	—	8,000	2,500	2,000	12,500	
P.S.P.	—	—	—	10,000	—	—	10,000	This is a conservative estimate for all the P.S.P. in the country in use on airfields or as fencing, etc. With the right persuasion, it might be released
				68,800	2,500	4,350	152,170	

operation. Such a schedule is not economical or practical in practice; the plant would operate 24 hours a day for only 200 days per year to produce the same tonnage. This would leave at least 100 days open for greater production when required. Thus, the proposed plant could produce 30,000 long tons per year, or more if it were in operation more than 300 days per year. It could operate at least 330 days and still have sufficient time for repairs.

(d) **Raw materials.** No deposit of iron ore of commercial value has been found in Burma, and no coal of coking quality is known to be available. It is therefore proposed to manufacture steel products from steel scrap. The accumulation of steel scrap from the war, plus the new scrap generated each year, is estimated to be sufficient to support the operation of a moderate-sized steel products plant capable of making the Union of Burma at least partially independent of imports.

(1) *Steel scrap*

Initially, only steel scrap of melting grades will be required. A survey of the present No. 1 and No. 2 steel scrap accumulation has been made by Mr. John Hipwell under the auspices of the United Nations, and is shown in Table XXII–27 (*see previous page*). This survey suggests that a total of 152,000 long tons of suitable scrap may be available in Burma. The estimates have been reviewed and have been found to be basically sound.

The five-year average export of steel scrap from Burma, from 1932–33 through 1936–37, was 10,237 long tons. Considering the total annual imports of steel products into Burma, there should be at least 10,000 long tons of new scrap generated each year. As Burma develops industrially, the generation of new scrap should increase proportionately. It is therefore conservative to assume a ten-year average production of 10,000 long tons of new scrap per year. Of this amount it has been estimated by GUB officials that approximately 4,000 long tons of worn-out railway rail are included in the total annual scrap accumulation figure. It is proposed that this be re-rolled into high carbon steel products, thus by-passing the electric furnace.

The capacity of the proposed plant has been established at 20,000 long tons per year. On this basis, the annual raw material requirements would be as follows:

16,000 long tons of mixed scrap (without rails)
4,000 long tons of railroad rails

20,000 long tons per year.

The 16,000 tons of mixed scrap should initially be taken from the accumulated reserve of 152,000 long tons to prevent further oxidation and appropriation losses. This reserve then would last 152,000/16,000 or 9·5 years.

The plant costs, as shown later, are based upon a 100% amortization, or write off, in 20 years. During that period there should be 200,000 long tons of new scrap generated, of which (4,000 × 20) 80,000 long tons would be railway rail, leaving a balance of 120,000 long tons of mixed steel scrap. This balance of mixed scrap would be used when the present accumulation is exhausted, and would supply the plant for 120,000/16,000 or 7·5 years.

The plant could operate for 17 years at a rate of 20,000 tons per year using domestic scrap only. There is an apparent shortage of 16,000 × 3, or 48,000 long tons, to balance out the full 20 years. This could be supplied by imported scrap or steel billets.

The entire supply would be as follows:

Accumulated scrap	152,000 L.T.
New scrap (10,000 × 20)	200,000 L.T.
Imported scrap or billets	48,000 L.T.
	400,000 L.T.

$$\frac{400{,}000}{20{,}000} = 20 \text{ years.}$$

The use of imported billets is not uneconomical. At the present time these are quoted f.a.s. Japan at $93.00 per metric ton which is equivalent to K445 per long ton. With an estimated freight rate of K25 per long ton, these could be delivered for about K470 per long ton. This compares to the estimated manufacturing cost of billets in the proposed plant of K337. If 4,000 long tons were imported each year, the increase in cost would be 4,000 × (470−377), or K5,32,000. This amount spread over 20,000 long tons, would increase the average cost by only K26.60 or by 4·6%.

To collect the existing scrap scattered all over Burma, and to collect all future scrap generated, it is suggested that the most efficient and cheapest method would be to take advantage of existing GUB agencies, the Civil Department and PWD. The town officers have all necessary authority and power, which may be required in recovering appropriated scrap, and the PWD has the men and equipment required.

(2) *Iron ore*

No iron ore deposits of commercial importance have been found in Burma. However, iron-bearing ore has been found on Cheduba Island which has been analyzed and found to contain 53·57% iron oxide, 24·02% silica, and 22·02% moisture. The extent of this deposit should be determined to establish whether it is great enough to be of commercial value.

(3) *Pig iron*

The projected zinc smelter for Myingyan will produce 2,700 long tons per year of pig iron as a by-product. This would be most valuable in supplying Burma's iron foundries which now operate on a small scale.

(4) *Power*

The steel plant will require 14,827,200 kWh per year of electric power. If operated 300 days per year, the daily requirement will be 49,424 kWh. The cost is estimated to be K0.20 per kWh. It is proposed initially to obtain this power from the Rangoon thermal plant system, if the new load can be carried. Later, this load may be carried by the proposed Pegu River hydroelectric generating plant. A standby power plant for emergency use is included in the project.

(5) *Miscellaneous*

Other materials are minor. Fuel oil, coal, sulphuric acid, zinc and other chemicals will be needed. Most of these will be available nationally as the industrial development program progresses. Some must be imported.

(e) Plant location. Rangoon is the largest metropolitan area of the Union of Burma, is the industrial and business center, and is the principal seaport of the nation. The city is also connected by water, rail and highway to all parts of the country, and is the most important distribution center. For these reasons the proposed steel products plant should be located in the Rangoon area.

It is proposed that the steel products plant be erected in the Insein suburban area north of the city of Rangoon, on a site acquired by the Government for industrial purposes. This property is served by highway and by a main line railway. However, there are several reasons why the steel plant should not be located on this tract. In the first place, this site does not front on the Rangoon River or its tributaries. As more of Burma is accessible by water transport than by rail or highway, it is important that the proposed steel plant be located where it can be served by water transport. In such a location, scrap can be delivered directly to the plant by barge, and the finished product can be distributed by the same means, as well as by rail or highway. Any imported materials, such as iron ore, pig iron, steel scrap or steel billets, can be landed directly at the plant, thus avoiding rehandling and inland transportation costs. Furthermore, if the present search for iron ore in commercial quantities in the Union of Burma is successful, the steel plant would be enlarged. In such event, the iron ore, coal or coke, and limestone, would be brought to the plant by water, as this is universally the cheapest method of transportation for bulk materials.

In the second place, one part of this industrial site is already occupied by the Government cotton spinning and weaving factory, and a second has been allocated for a Government pharmaceutical plant. These two industries should not be located adjacent to a steel plant as their products must be manufactured in clean atmospheric conditions which are almost impossible to obtain near a steel plant.

For these reasons the site for the steel products plant should be west of the present government-owned tract, on the east bank of the Hlaing River. Plate 14 shows a suggested location for the plant.

(f) The process. Operating on steel scrap exclusively, the furnace will be of the electric arc type, which is best suited for this purpose. If additional output is desired imported steel scrap or steel billets may be used. The billets would be the most economical as they need only to be heated before going to the rolling mill.

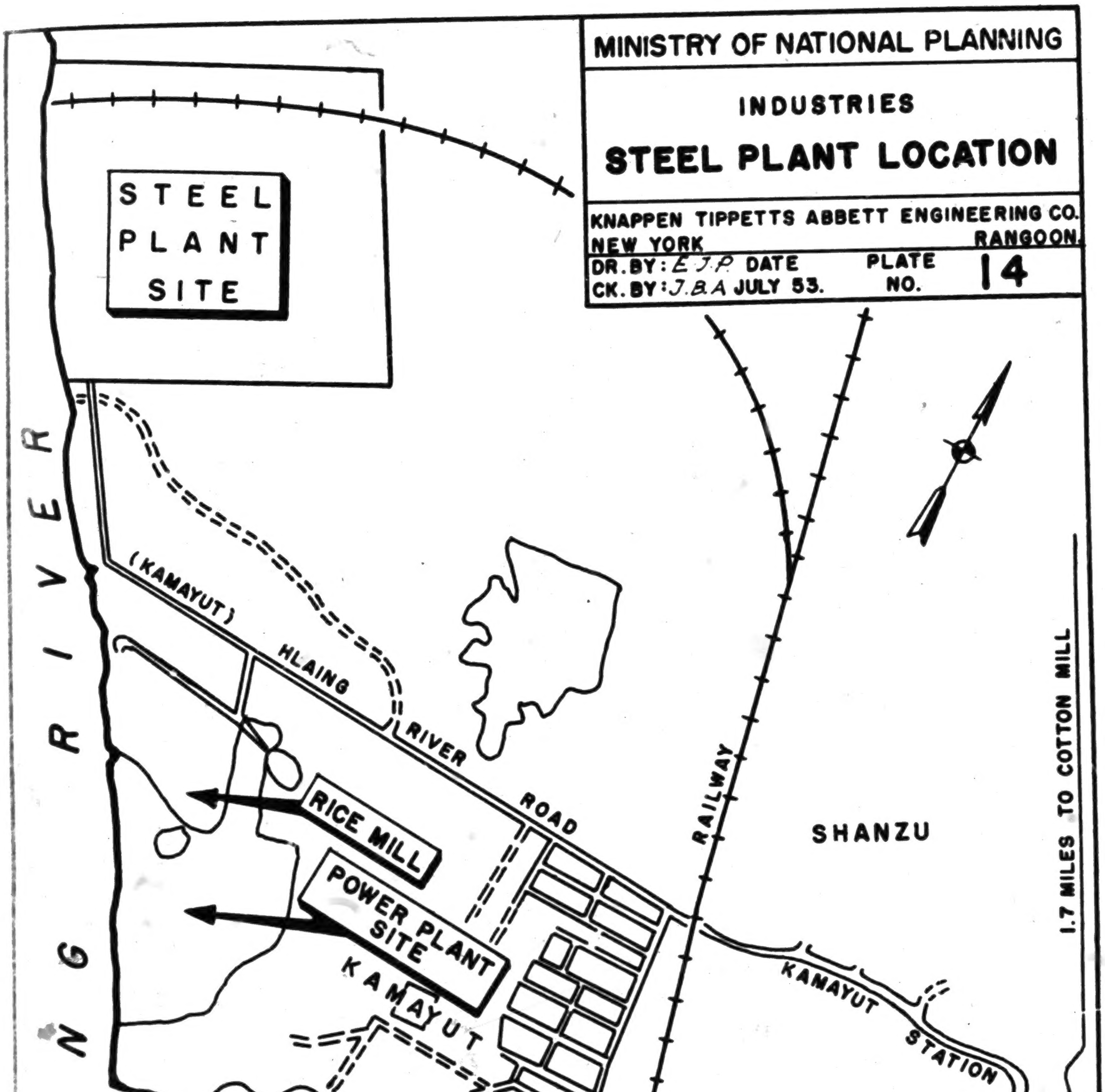
The equipment should consist of an electric arc melting furnace, a rolling mill, wire drawing mill, a plate-sheet mill, a shape and bar mill, a cold and hot products mill, and a galvanizing plant. Auxiliary equipment and facilities such as offices, laboratory shops, warehouses, emergency power plant, inter-plant railway, and water and sewerage must be included.

On Plate 15 is shown a suggested plant layout of the proposed steel products plant.

(g) Estimated costs. The total capital required to erect the 20,000-long-ton capacity steel products plant, and to place it in operating condition, is estimated as follows:

	K
(1) Machinery and Equipment	
(*a*) 15-Ton Electric Furnace	32,00,000
(*b*) Rolling Mill	1,16,00,000
(*c*) Wire Drawing Mill	28,00,000
(*d*) Electrical Equipment	26,00,000
(*e*) Water and Sewerage System	4,75,000
(*f*) Compressed Air System	70,000
(*g*) Fuel Oil System	75,000
(*h*) Shapes and Store Room	11,75,000
(*i*) Laboratory	62,500
(*j*) Inter-plant RR and Rolling Stock	7,50,000
(*k*) Automotive Equipment	1,50,000
Subtotal, Machinery and Equipment	2,30,27,000
(2) Structural Steel	28,65,500
(3) Ocean Freight	20,60,500
(4) Insurance	3,45,000
(5) Duty	
(6) Burma Inland Freight	2,00,000
(7) Machinery Erection	27,00,000
(8) Foundation and Construction Work	43,50,000
(9) Burma Living Costs and Travelling Expense: Foreign Experts	4,72,000
(10) Rental on Construction Equipment	4,72,000

(*Continued on page 786*)



MINISTRY OF NATIONAL PLANNING

INDUSTRIES

STEEL PLANT LOCATION

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON.
DR. BY: E.J.P. DATE PLATE NO. 14
CK. BY: J.B.A JULY 53.

STEEL PLANT SITE
HLAING RIVER
(KAMAYUT) HLAING RIVER ROAD
RICE MILL
POWER PLANT SITE
KAMAYUT
RAILWAY
SHANZU
KAMAYUT STATION ROAD
1.7 MILES TO COTTON MILL
KAMAYUT Ch.
.733 MILES TO UNIVERSITY AVENUE
RANGOON INSEIN ROAD
SCALE IN FEET.
400
200
0
400

(11) Overhead Expense: Owning Company, Officers' Salaries, Clerical Salaries, Travelling Expense, Cables, Telegrams, Telephones, during Construction	4,72,000
(12) Contingencies	4,72,000
(13) Total Erected Cost	3,74,36,000
(14) Real Estate—graded	18,72,000
(15) Total Plant Cost	3,93,08,000
(16) Working Capital	28,32,000
(17) Total Capital Investment	4,21,40,000

Note: Cost estimate does not include connecting railroad spur to plant site, or of access highway, electric power line, water line, etc., outside of plant site.

(h) Construction schedule. It is estimated that approximately three years will be required from the time consulting engineers are retained to complete the proposed steel plant. This time may be broken down as follows:

(1) Survey of site, preparation of preliminary drawings and specifications, and ordering machinery, equipment, and materials: six months;

(2) Grading of plant site, construction of foundations, roads, docks, railway connection, water and power connection and warehouses: to begin within six months, and to be complete before one year;

(3) Machinery delivery to start within 15 months of placement of orders, and to be completed one year later;

(4) Erection to take about 12 months, the time overlapping the machinery delivery period.

(i) Expenditure schedule. The total cost of the plant is divided as follows between foreign exchange expenditures (K3,40,08,000) and local currency (K81,32,000).

(1) *Foreign exchanges*

The foreign exchange required for the first year would be principally for the engineering work and for the initial payments for machinery, equipment and materials. The initial payment will vary with the custom of the manufacturer and will range usually between 15% and 25%. For budgeting purposes 25% should be used, which would require the equivalent of K80,01,000 in foreign exchange. An additional amount of K4,99,000 should be allowed for engineering work and miscellaneous purposes, making the total estimated expenditure for the first year K85,00,000 or its equivalent. Expenditures for the second and third years would be about equal as partial payments are made on the machinery, equipment and material, and would be approximately K1,27,54,000 for each year.

(2) *Local currency*

The kyat expense for the first year would consist mainly of the acquisition and grading of the plant site and of foundation construction work. This is estimated to cost K30,00,000. The balance of the kyat expense would be divided about evenly during the next two years at K25,66,000 for each year.

The uniform annual figure necessary for 100% capital recovery in 20 years of both local currency and foreign exchange is obtained by the following factors as follows:

Currency	*Kyats*	*Factor*	*Annual Cost (K)*
Local	81,32,000	× ·07358	5[illegible],350
Foreign Exchange	340,08,000	× ·08024	2[illegible],800
		Annual Total	33[illegible]150

In the preceding, the total should be debited against the annual cost of manufacture on a unit-of-production basis dependent upon the annual production of each product.

(j) Production costs—cost of sales

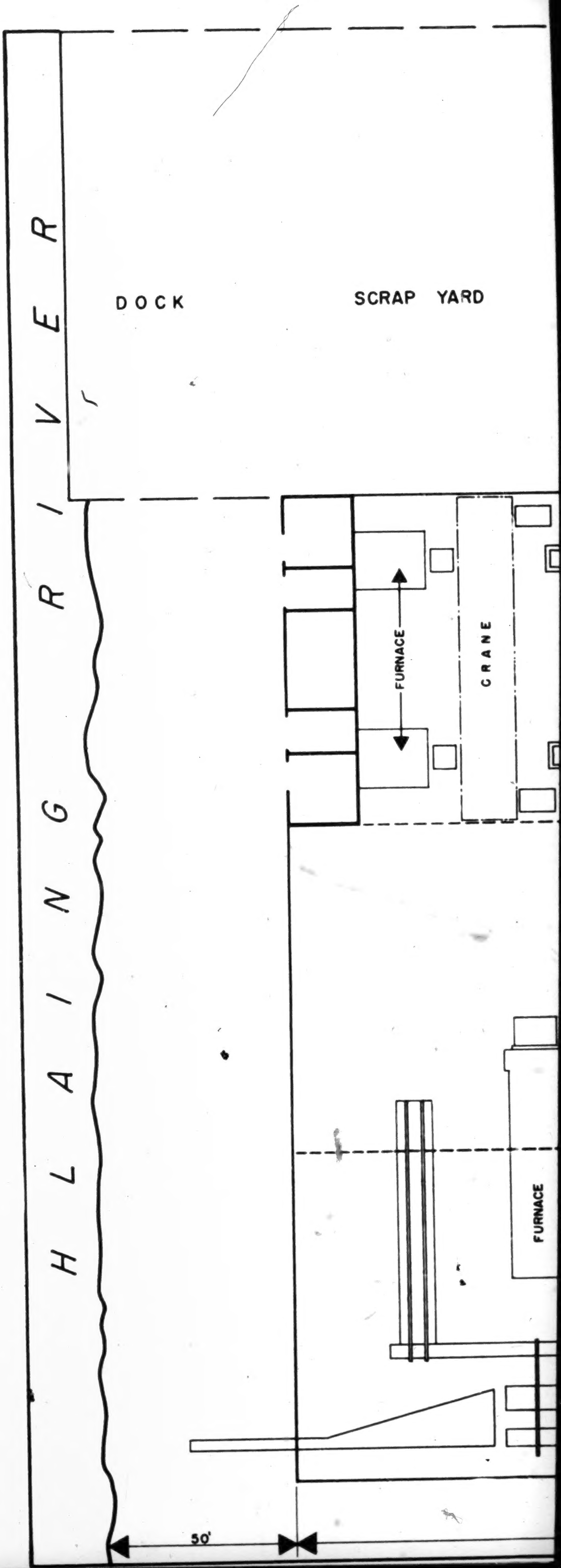
(1) *Cost of sales*

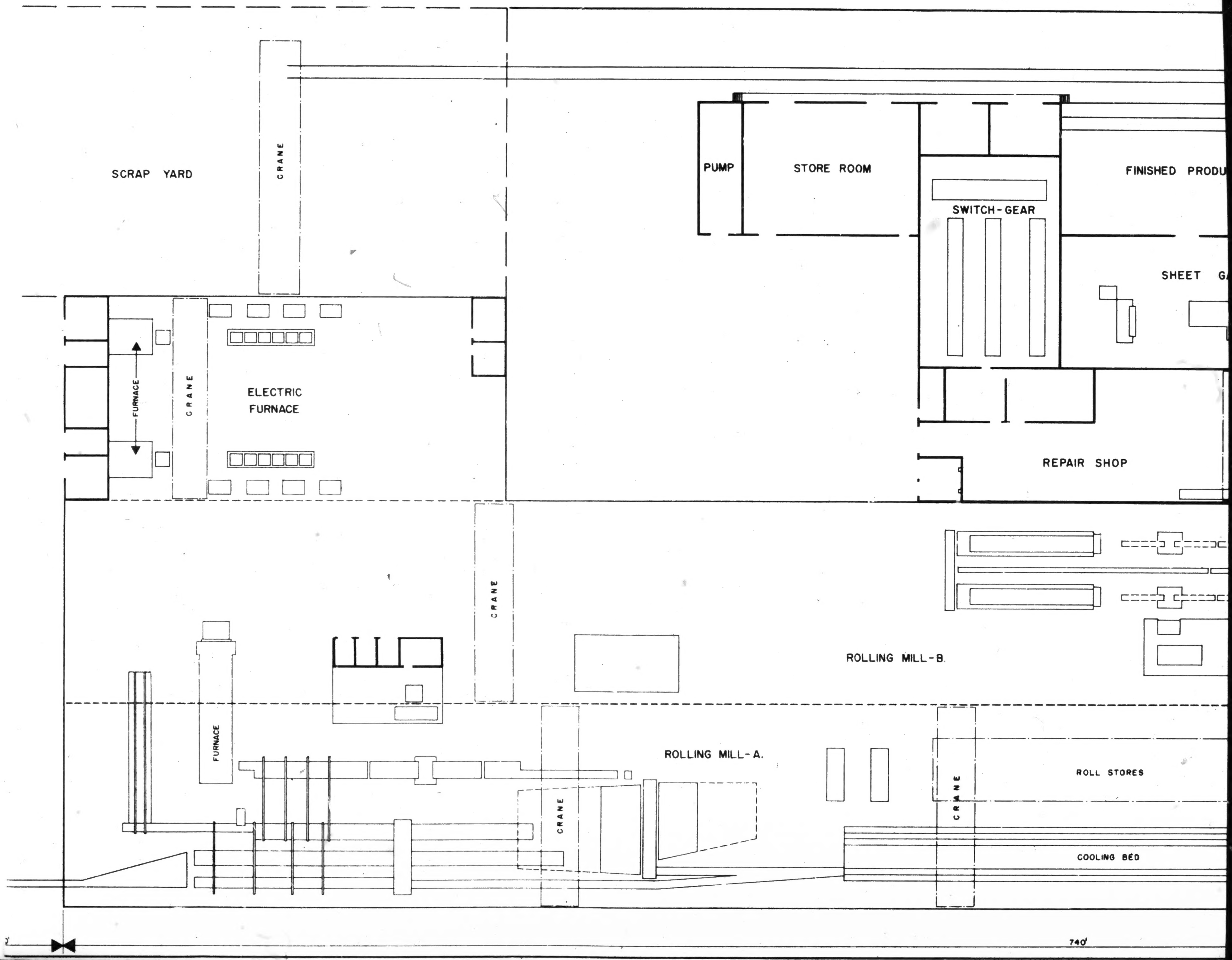
An estimate has been made of the cost of producing and selling the various types of steel products to be manufactured. This is on Table XXII–28 (see p. 788). This is based upon using domestic scrap only, with no imports of scrap or billets. The cost of manufacturing and of sales of the various products is shown below.

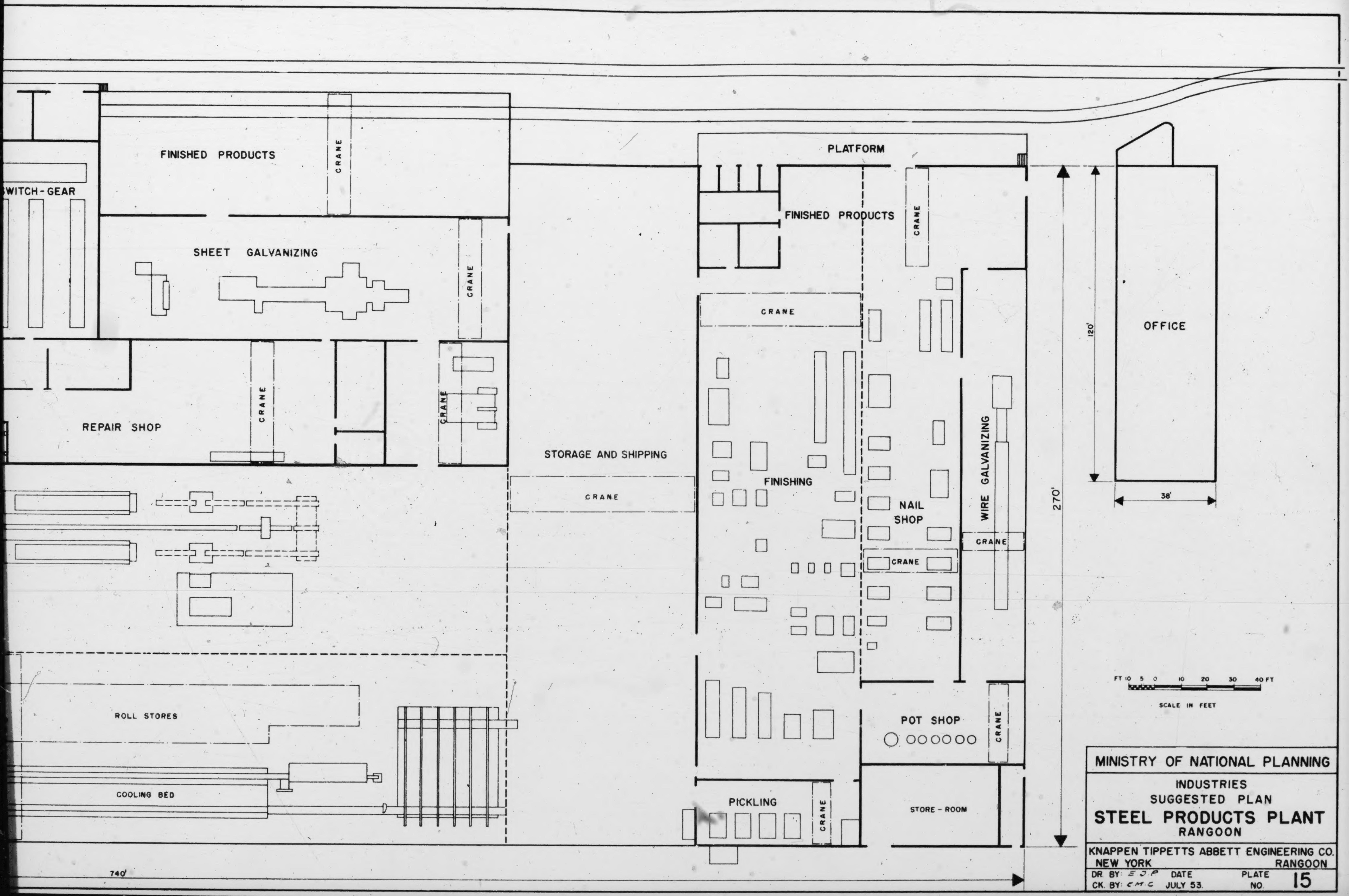
Commodity	*Long Tons per Year*	*Estimated Cost per L.T.* (K)	*Estimated Total Cost* (K)
Shapes and Bars	4,100	402	1[illegible],200
Drawn Goods	1,150	463	[illegible],450
Black Plate and Sheets	1,850	446	[illegible],450
Galvanized Sheets	6,600	693	4[illegible],905
Nails, Loops, Barbed Wire	4,455	540	24[illegible],325
Hot Process Products	1,305	720	[illegible],345
Cold " "	770	880	6[illegible],345
Total or Average	20,230	574	1,10[illegible],580

The preceding list of products meets closely the requirements of the bid invitation of the Ministry of Industry and Mines, as in the succeeding table, except for the provision for sheets for private consumption.

Item	*Ministry Requirement (L.T.)*	*Report Requirement (L.T.)*
Shapes and Bars	3,991	4,100
Galvanized Sheets	5,500	6,600
Black Sheets and Plates	1,310	1,850
Nails, Galv. Wire, Barbed Wire	4,427	4,455
Hot and Cold Process Production	1,875	2,075
Other Drawn Products	—	1,150
Total	17,103	20,230


HLAING RIVER
DOCK
SCRAP YARD
FURNACE
CRANE
FURNACE
50'

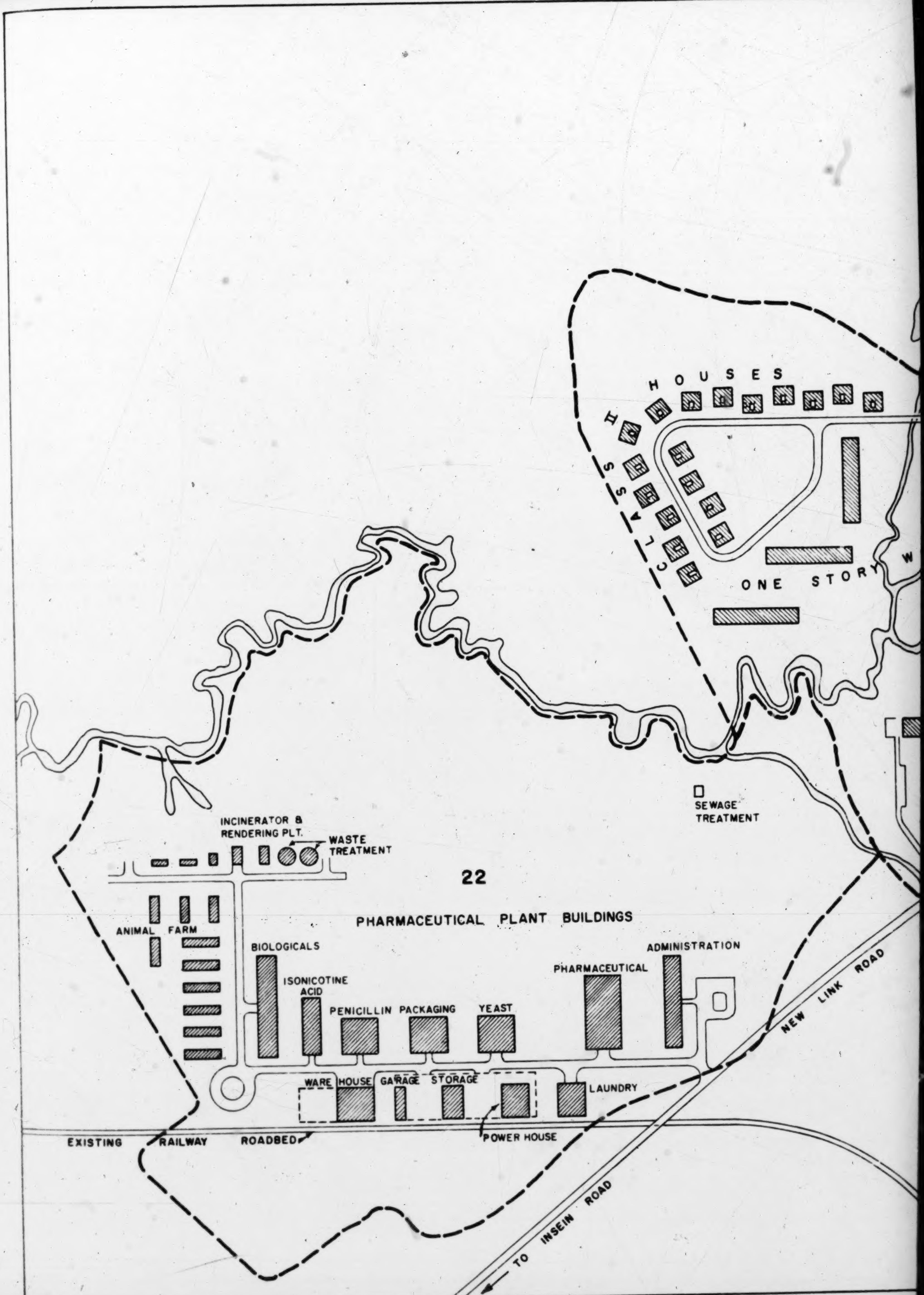

SCRAP YARD
CRANE
PUMP
STORE ROOM
SWITCH-GEAR
FINISHED PRODU
SHEET G
FURNACE
CRANE
ELECTRIC FURNACE
REPAIR SHOP
CRANE
ROLLING MILL-B.
FURNACE
ROLLING MILL-A.
CRANE
CRANE
ROLL STORES
COOLING BED
740'

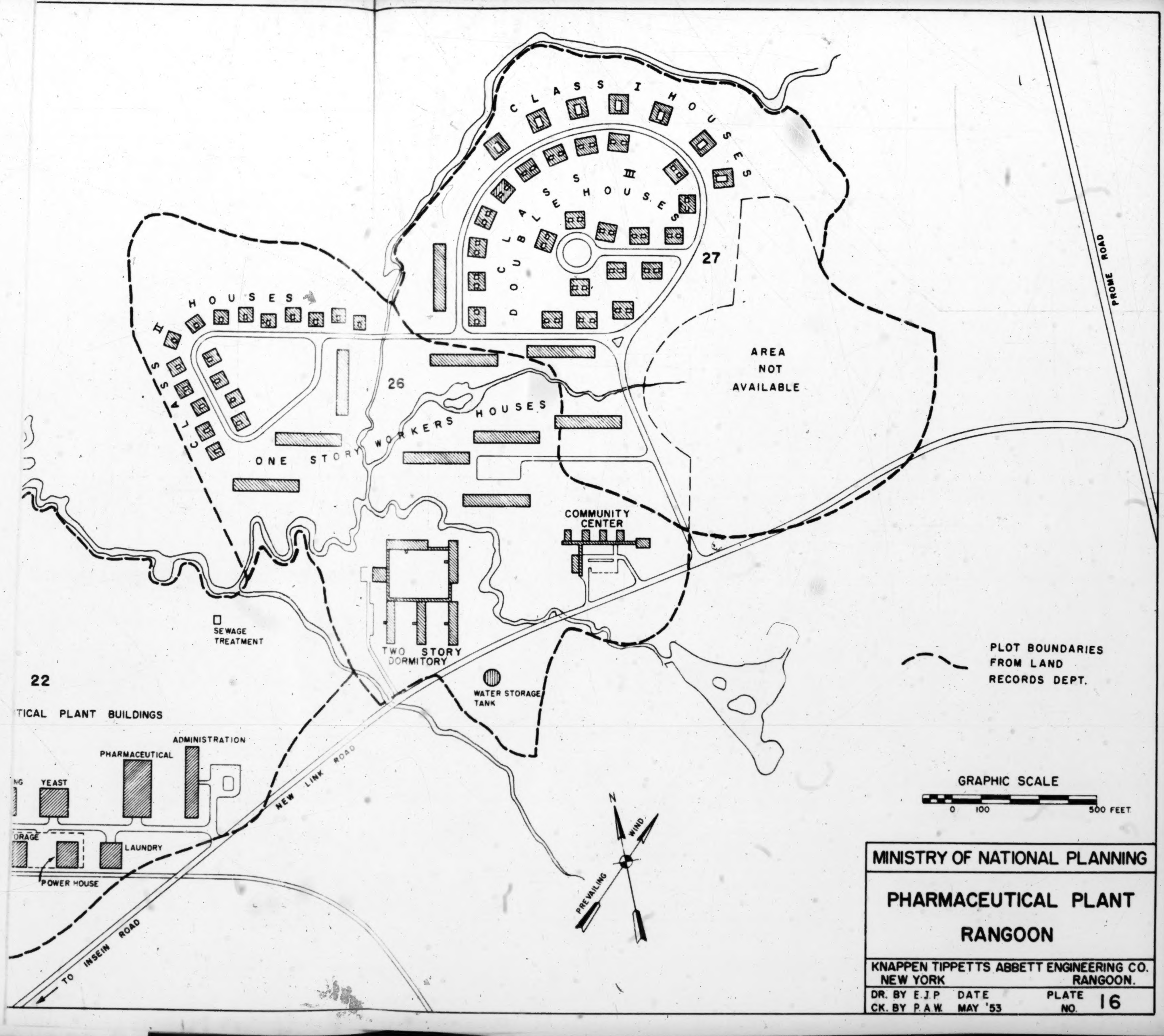

FINISHED PRODUCTS
CRANE
SWITCH-GEAR
SHEET GALVANIZING
CRANE
REPAIR SHOP
CRANE
CRANE
STORAGE AND SHIPPING
CRANE
ROLL STORES
COOLING BED
740'
PLATFORM
FINISHED PRODUCTS
CRANE
CRANE
FINISHING
NAIL
SHOP
CRANE
WIRE GALVANIZING
CRANE
POT SHOP
CRANE
PICKLING
CRANE
STORE - ROOM
270'
120'
OFFICE
38'
FT 10 5 0 10 20 30 40 FT
SCALE IN FEET

MINISTRY OF NATIONAL PLANNING

INDUSTRIES
SUGGESTED PLAN
STEEL PRODUCTS PLANT
RANGOON

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON
DR. BY: E J P DATE PLATE
CK. BY: C.M.C JULY 53. NO. 15


CLASS II HOUSES
ONE STORY W
SEWAGE TREATMENT
INCINERATOR & RENDERING PLT.
WASTE TREATMENT
22
PHARMACEUTICAL PLANT BUILDINGS
ANIMAL FARM
BIOLOGICALS
ISONICOTINE ACID
PENICILLIN
PACKAGING
YEAST
PHARMACEUTICAL
ADMINISTRATION
WARE HOUSE
GARAGE
STORAGE
LAUNDRY
POWER HOUSE
EXISTING RAILWAY ROADBED
NEW LINK ROAD
TO INSEIN ROAD


CLASS I HOUSES
DOUBLE CLASS III HOUSES
CLASS II HOUSES
27
26
AREA NOT AVAILABLE
PROME ROAD
ONE STORY WORKERS HOUSES
COMMUNITY CENTER
TWO STORY DORMITORY
SEWAGE TREATMENT
WATER STORAGE TANK
22
TICAL PLANT BUILDINGS
ADMINISTRATION
PHARMACEUTICAL
NG
YEAST
ORAGE
LAUNDRY
POWER HOUSE
NEW LINK ROAD
TO INSEIN ROAD
N
PREVAILING WIND
PLOT BOUNDARIES FROM LAND RECORDS DEPT.
GRAPHIC SCALE
0
100
500 FEET

MINISTRY OF NATIONAL PLANNING

PHARMACEUTICAL PLANT
RANGOON

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON.
DR. BY E.J.P. DATE PLATE
CK. BY P.A.W. MAY '53 NO. 16

As the proposed plant is flexible the quantities of each commodity may be varied to suit demand.

(2) *Profits at current wholesale prices*

Based upon the current selling prices of these commodities in Rangoon, and upon the quantities it is planned to produce, the following gross profit, without taxes, would result:

(3) *Manufacturing costs—cost of sales and profit*

	L.T./Yr.	*Total (K)*	*Average (K)*
Estimated Average Sales (Current Prices)	20,230	2,38,77,500	1,180.00
Less Cost of Sales	20,230	1,16,07,580	574.00
Gross Profit or Surplus		1,22,69,920	606.00
Return on Investment		27·5%	

(4) *Profits at current prices less duty and dealer profit*

Based upon a c.i.f. Rangoon cost, plus stevedoring, port charges and warehousing, but without license fees, duty, or dealers' profit, the foregoing estimated gross profit would be as follows:

(5) *Manufacturing costs—cost of sales and profit*

	L.T,/Yr.	*Total (K)*	*Average (K)*
Estimated Average Sales (Adjusted Current Prices)	20,230	1,83,34,985	906.00
Less Cost of Sales	20,230	1,16,07,580	574.00
Gross Saving to GUB		67,27,405	332.00
Return on Investment		15·95%	

The preceding government warehouse cost price of imported steel products is then comparable to the manufacturing, warehousing and packaging cost of the same products manufactured in Burma in a wholly government owned plant operated on a tax-free and non-profit basis. Both prices would be those paid by government agencies accepting delivery f.o.b. government warehouse, or for sale to other purchasers on a non-profit basis.

From the last table it is clear that it would be definitely advantageous for the Government to own and operate the proposed steel products plant, as a saving of K67,27,405 per year would result. This is equivalent to a price reduction of 35% compared to the cost of duty-free importations, if the entire output was purchased by government agencies.

(k) **Economic features.** The manufacture of the selected steel products in the proposed plant will release foreign exchange for other purposes, and its operation will not require large importations of materials or supplies. It is estimated that the foreign exchange required for the importation of the selected 20,000 long tons of steel products to be manufactured in Burma amounts to K1,66,00,000 per year.

The plant will employ approximately 500 people at manufacturing wage rates and salaries. The annual payroll will exceed K11,00,000, which should add importantly to the national income.

An important feature of the project is that it will eventually be almost completely self-sustaining. The plant is also of importance from a defense viewpoint, as the best alloy steels for use in the manufacture of arms are made in electric furnaces.

(l) Conclusions and recommendations. There is no question of market and the necessary raw materials appear to be sufficient to support the proposed plant. The estimated manufacturing costs indicate that this plant can operate at a good profit, or that the prevailing prices may be reduced drastically.

As all steel products are now imported and as the profits are assured, the program should be implemented at once, and placed in the First-year Plan.

(32) Pharmaceuticals and Drugs

(a) The market. The current annual consumption of pharmaceuticals and related products in Burma amounts to K1,88,10,444 plus certain items procured by the Government duty free and additional supplies furnished by WHO and TCA. There is sufficient demand for pharmaceuticals and drugs to support an industry designed to supply the various medicinal products in general use by the Ministry of Social Services in its activities concerned with public health.

(b) The plant. The details of a plant to manufacture bulk pharmaceuticals, biologicals, vitamins, yeast, penicillin, nicotinic acid, milk substitute and infant foods are covered in a project report previously submitted to Government. The plant proposed would, in the beginning, manufacture only those items required by Government with possible surpluses in certain products to be made available to the pharmaceutical and medical professions. Eventually the plant could supply the total needs of Burma in biological vaccines, antibiotics and sulfa drugs.

The plant would consist of a group of self-contained departments housed in separate buildings supplied with the required utilities, electricity, compressed air, steam, treated water and gas from central facilities, and distilled water (Plate 16).

The estimated cost of the plant is given in the following Table XXII–29.

It would require about three years to design, construct, and place the plant in operation. The engineering design for the complete plant must be finished during the first year, and all facilities in Group A started as promptly as detailed plans are available. Groups B and C can follow as needed.

TABLE

ESTIMATED MANUFACTURING

DEPARTMENTAL

Item	Spread Costs	Furnace Department		Rolling Mill		Rolling Mill Shapes and Bars	
	K		K		K		K
1. General and Administrative Expense	4,86,300	—	1,21,575	—	1,21,575	—	—
2. Electrical Distribution	2,65,900	—	66,475	—	66,475	—	—
3. Water System	34,490	—	3,100	—	29,320	—	—
4. Compressed Air System	17,035	—	6,830	—	4,255	—	—
5. Fuel Oil System	44,350	—	885	—	31,505	—	—
6. Railroad	16,500	—	2,360	—	2,360	—	—
7. Shops and Stores	2,61,820	—	20,200	—	2,06,270	—	—
8. Depreciation	27,54,540		,89,000	—	8,28,140	—	4,95,000
LABOR							
9. Manager	—	1		1		—	—
10. Foreman		1 · 3 laboratory	25,000		17,000	—	—
11. Unskilled Men	—	3 Furnace for	9,150	1		2	6,100
12. Social Charges	—	62	54,500	—	—	68	59,000
	—	—	88,650	—	17,000	—	65,100
SUPPLIES							
13. Lubricants	—	—	1,120	—	560	—	1,700
14. Water	—	—	150	—	250	—	—
15. Oxygen	—	—	8,100	—	—	—	—
16. Acetylene	—	—	5,450	—	—	—	—
17. Fuel Oil	—	—	5,100	—	1,70,000	—	—
18. Zinc	—	—	—	—	—	—	—
19. Sulphuric Acid	—	—	—	—	—	—	—
20. Milk of Lime	—	—	—	—	—	—	—
21. Zinc Chloride	—	—	—	—	—	—	—
22. Sawdust	—	—	—	—	—	—	—
23. Hydrochloric Acid	—	—	—	—	—	—	—
24. Ammonium Chloride	—	—	—	—	—	—	—
MAINTENANCE							
25. Maintenance	—	—	22,750	—	98,000	—	88,000
26. Brick Lining—Furnace	—	—	11,150	—	—	—	—
27. ,, ,, —Saddles	—	—	1,42,500	—	—	—	—
28. ,, Special for Ingot Casting	—	—	1,11,500	—	—	—	—
29. Power kWh at K0.20	—	Furnace 10,067,200 Other 940,000	20,13,440 1,88,000	— 330,000	— 66,000	— 7,000,000	— 1,20,400
30. Scrap (K100 L.T.)	—	16,000 L.T.	16,00,000	—	—	—	—
31. Added Other Material	—	5–8·5%	80,000	—	—	—	—
32. Rails (K200 L.T.)	—	—	—	—	—	4,000 L.T.	8,00,000
33. Purchased Billets	—	—	—	—	—	—	—
34. Material in Process	—	—	—	—	—	10,125 Ingots and Slabs at 337	34,12,125
35. Gross Cost	—	—	48,76,985	—	16,58,710	—	50,47,425
36. Credits	—	—	—	—	—	(2,125 T)	2,12,500
37. Net Cost	—	19,360 L.T. Ingots and Slabs	48,76,985	19,360 L.T. Throughput	86 251	Net Cost 12,000 L.T.	48,34,925
Cost per L.T.	—	—	251	Ingots and Slab Ingots	337	Net	402

XXII - 28

COST OF STEEL PRODUCTS

COSTS

Rolling Mill Plates and Sheets		*Wire Drawing and Rod Mill*		*Cold Processing Department*		*Hot Processing Department*		*Nails, Loops, Barbed Wire*		*Galvanizing Sheets*	
	K		*K*		*K*		*K*		*K*		*K*
—	—	—	48,630	—	48,630	—	48,630	—	48,630	—	48,630
—	26,590	—	26,590	—	26,590	—	26,590	—	—	—	26,590
—	—	—	2,070	—	—	—	—	—	—	—	—
—	—	—	1,190	—	1,190	—	1,190	—	1,190	—	1,190
—	—	—	885	—	—	—	3,540	—	3,100	—	4,435
—	—	—	2,360	—	2,360	—	2,360	—	2,360	—	2,360
—	—	—	7,575	—	7,575	—	7,575	—	7,575	—	5,050
—	2,01,000	—	1,07,500	—	96,500	—	1,37,500	—	1,21,000	—	1,04,500
—	—	1		1		1		1		1	
—	—	Prop 1/5	4,500	Prop 1/5	4,500	Prop 1/5	4,500	Prop 1/5	4,500	Prop 1/5	4,500
2	6,100	1		1		1		1		1	
48	41,500	18	22,600	36	31,250	26	22,300	22	18,850	34	29,100
—	47,600	—	27,100	—	35,750	—	26,800	—	23,350	—	33,600
—	1,150	—	1,150	—	1,150	—	1,150	—	1,150	—	600
—	—	—	3,260	—	—	—	250	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	5 kg/T (27·1 T/Yr)	4,650	—	—	110 T/Yr	18,400	100 T/Yr	17,000	165 T/Yr	27,100
—	—	—	—	—	—	—	—	—	—	1200 T/Yr	14,70,000
—	—	216 T/Yr	28,400	—	—	—	—	4 T/Yr	510	—	—
—	—	—	11,150	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	1·5 T/Yr	2,460	—	—
—	—	—	—	—	—	—	—	—	600	—	—
—	—	—	—	—	—	—	—	—	—	540 T/Yr	60,200
—	—	—	—	—	—	—	—	—	—	60 T/Yr	34,800
—	34,000	—	8,950	—	8,500	—	6,460	—	8,150	—	5,250
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
825,000	1,65,000	680,000	1,36,000	144,000	28,800	384,000	76,800	342,000	68,400	165,000	33,000
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
9,235 L.T. Ingots and Slabs at 337	31,23,570	6,500 L.T. Cogged Steel at 402	26,13,000	850 L.T. Drawn Goods at 463	3,93,550	1,400 L.T. Bars at 402	5,62,800	4,500 L.T. Drawn Goods at 463	20,83,500	6,000 L.T. Plate and Sheets at 446	26,76,000
	36,46,510	—	30,57,560	—	6,86,345	—	9,46,845	—	24,12,325	—	45,66,905
(1,385 T)	−1,38,500	—	—	(80 T)	−8,000	(95 T)	−9,500	—	—	—	—
Net Cost	35,08,010	—	30,57,560	—	6,78,345	—	9,37,345	—	24,12,325	—	—
7,850 L.T. Net	446	6,500 L.T. Drawn Goods	463	770 L.T.	880	1,305 L.T.	720	4,455 L.T.	540	6,600 L.T. G.I. Sheets	693

TABLE XXII – 29

COSTS OF PHARMACEUTICAL PLANT

Department or Item	*Total Cost (K)*	*Local Cost (K)*	*Foreign Currency (K)*
GROUP A			
Bulk Pharmaceuticals	95,18,050	22,46,750	72,71,300
Biologicals	29,02,250	12,43,312	16,58,938
Packaging Department	22,04,000	7,62,375	14,41,625
Administration and Laboratories	2,37,500	1,78,125	59,375
Warehousing	4,98,750	3,74,062	1,25,688
Utilities	38,08,550	8,76,850	29,31,700
Yeast	16,05,000	3,82,500	12,22,500
Engineering and Contingencies	41,13,500	11,00,100	30,13,400
Total Group A	2,48,87,600	71,64,074	1,77,23,526
GROUP B			
Penicillin	37,90,500	9,95,125	27,95,375
Nicotinic Acid	22,36,775	5,60,073	16,76,702
Total Group B	60,27,275	15,55,198	44,72,077
GROUP C			
Milk Substitute and Infant Food	29,40,107	6,53,863	22,86,244
Grand Total	3,38,54,982	93,73,135	2,44,81,847

The annual production of the plant is estimated at K1,41,55,000 initially, rising to K2,00,00,000 after six years of operation. It is estimated that the manufacturing costs of the products will not exceed K1,09,00,000 for an outturn of K1,41,55,000; the savings per year would therefore be about K32,55,000 over import costs.

(c) **Raw materials.** Some of the raw materials are indigenous, such as plants for natural extracts and alkaloids, cultures for biological products and penicillin, and cultures for yeast. Other basic raw materials are available, but for pharmaceuticals must be converted into usable intermediates, such as sugar to alcohol, acetalihyde and acetanilide; rice for starch and dextrose, etc. Other raw materials will result from other industries under consideration such as acetic acid and methanol from wood distillation, ammonia from the proposed fertilizer plant and sulphuric acid. A detailed analysis of each raw material will be required to determine the economics of manufacture compared with importation.

(d) **Management.** The manufacture of pharmaceutical products involves complex chemical processes and close coordination of manufacturing procedures. The plant will require more technicians and experienced supervisors than it will be possible to train during the time required to implement the project. The multiplicity of problems that will be encountered in training personnel for highly specialized production would be increased considerably by the number of people that require simultaneous training. The administration and maintenance of the plant require judgement that can be accumulated only by experience. In view of the problems involved in operating a plant of this type it is preferable that it be operated under a management contract with a firm experienced in the manufacture of pharmaceuticals.

(e) **Conclusions and recommendations.** The products which are proposed in this project are essential to the health of the nation. Therefore the plant will be making a substantial and worthwhile contribution if it enables Burma to become self-sufficient on a number of critical drugs and other medical items.

The child mortality rate, the venereal disease rate and the tuberculosis rate are all extremely high, and reduction in these would have large economic benefits to the individual, the community and the nation.

The production cost of some articles might be more than the c.i.f. cost, but in the majority of cases it would be lower. It is estimated that the investment could be repaid out of profits in approximately 11 years. Therefore the project can be justified on economic grounds, as well as national interest for self-sufficiency in items important to health and defense.

It is therefore recommended that the GUB immediately contract with a reputable pharmaceutical manufacturer to act as management agents for this project. The duties of the management agents would be: to brief the consulting engineers on the chemistry of the processes involved, advise the architects on manufacturing processes in order to obtain the most modern and efficient plant layout, train selected GUB personnel, provide technicians or management personnel where no GUB personnel are available and train counterparts for these positions, operate the plant until the GUB personnel are competent to take over, and provide continuing consulting service for new products, new applications for old products, new processes, etc.

After obtaining the services of the pharmaceutical manufacturer, completion of plant design and letting construction contract could be accomplished within 12–18 months. Completion of buildings is possible within 18–24 months from completion of design.

(33) Tobacco and Tobacco Products

(a) **The market.** The people of Burma consume more tobacco per capita than do the people of any other country except the United States, the consumption comparing as follows:

United States	10·1 pounds per year (1949)
Burma	9·7
New Zealand	9·0
Canada	7·3
United Kingdom	5·5

All forms of tobacco are used in Burma, the principal forms being mild cheroots, strong cheroots, cigars, cigarettes and pipe tobaccos. While the nation is self-sufficient as far as total production is concerned there is a shortage of some types, consequently Burma both imports and exports tobacco and tobacco products.

(b) **Tobacco production.** Approximately 130,000 acres of land are used for growing tobacco. Most of the land so used is flooded land on the banks of the large rivers. The holdings are small, the average being about five acres. The principal producing areas are in Thayetmyo, Tharrawaddy, Myingyan, Mandalay, Toungoo and the Pegu districts.

The recent crops have averaged 117,000,000 pounds per year of dried cured tobacco. This has an approximate wholesale value of K20,20,000 per year. In 1951-52 a total of 235,622 pounds of cured tobacco was imported at a declared value of K5,98,721. No export figures are available for the last three years. Imports of unmanufactured tobacco have decreased considerably since before the war when an average of more than 14,500,000 pounds was brought in each year. The imports of cured tobacco are principally Virginia types.

Cigarettes are the principal imported tobacco product, their quantity being much greater than that of cigars, pipe tobaccos and other forms together. In 1951-52 620,000,600 cigarettes (1,549,663 pounds) were imported at a declared value of K1,31,96,845. There are normally no exports of manufactured tobacco or tobacco products, except cigars.

(c) **Tobacco industry.** A tobacco industry has developed in Burma. Thirty-five factories produce cigars, 46 produce cheroots, four produce beedies, and three produce cigarettes. Rangoon has become the chief tobacco manufacturing center with 27 factories of the total of 88. Mandalay is a close second with 22. All cigarette plants are located in Rangoon. Myingyan, Prome, Bassein and Pegu have several tobacco plants.

The industry employs 5,083 people, 598 of whom are men and 4,485 women. Most of the factories are small. The cigar factories rarely employ more than 20 to 25 persons. Only ten plants employ more than 100, and of these five plants employ over 200. The largest employs 454. Most of the industry is on a cottage industry basis.

The curing and warehousing methods are not modern, and none of the factories have driers or humidifying equipment. Consequently the tobacco gets too wet and molds during the wet season, and is too dry during the dry season. All cigars, cheroots and beedies are hand made. Grades of some tobaccos are substandard.

None of the three cigarette factories at Rangoon are modern. Most of the equipment is Japanese and does not operate well or efficiently. The three plants have a rated capacity of about 655,000,000 cigarettes per year operating eight hours per day. The estimated actual production is only 38,000,000 cigarettes per year.

The plants, with present equipment, thus have the capacity to supply nearly all of the requirements of Burma.

Imports	620,000,600
National Production	38,000,000
Total	658,000,600
Capacity	655,000,000

The owners report that they cannot sell more Union-made cigarettes from the tobacco used because of the preference for the imported tobaccos containing Virginia tobacco blends. Virginia tobacco was introduced into Burma in 1935, but less than 2% of the tobacco acreage is used for the production of this type.

The problems of the industry are two-fold. The first is agricultural. Better grades of tobacco must be grown, and curing and drying methods improved. More tobacco of the Virginia types should be grown for cigarette use to reduce imports of unmanufactured tobaccos and of cigarettes. Better quality tobacco of the proper type would improve the quality of the cigars and cheroots and thus reduce the quantity of cigars imported. Nevertheless, Burma is almost self-sufficient in the manufacture of cigars.

(d) **Recommendations.** The manufacturing methods should be improved to produce a better-made product. The cigarette plants should be modernized by installing drying and humidifying equipment. This would improve output, reduce costs, and insure a better product.

As the existing cigarette plants have ample capacity to meet the national demand, there is no present need for additional manufacturing capacity. Since the consumer prefers imported blends of tobaccos to national blends the manufacturers should attempt to duplicate these in the national plants. As far as possible the required types of tobaccos should be grown in Burma. Until the successful production of suitable tobacco to meet the outside competition it would be more economical to import the proper cured tobaccos required. As the cost of the imported tobacco in cigarette form is four times the cost of the same tobaccos in the unmanufactured form, the importation of the cured tobacco for the local manufacture of cigarettes would save foreign exchange to the amount of K98,97,633 per year.

(34) Fruit Processing

The wide range of latitude and large differences in elevation and weather in Burma make it possible to find the optimum climatic conditions for growing almost all kinds of fruit. At present the principal fruit-growing section of Burma is in the Shan States. This area does not produce all of the fruit requirements; thus some fruit is imported. Orchards can be expanded to meet the country's requirements.

The fruit industry is too small at present to support modern plants for packing, storing and processing fruit or fruit products. A small experimental fruit canning plant has been established near Taunggyi. As fruit cannot be preserved or stored it must be sold when ripe for domestic consumption.

The importation of fruit that can be grown domestically is contrary to the objectives of the development program and as fruit is an important part of the diet of a healthy people, its production and processing should be encouraged.

A first step is to promote a program for increasing the acreage devoted to fruit growing, and to improve the quality and the yield of the fruit. When a sufficient quantity of fruit of acceptable grade has been grown, modern packing plants and fruit processing plants with cold storage facilities should be established.

The packing plants would pack the fruit to enable it to reach the consumer in the best possible condition. Cold storage would permit the sale of fruit to be spread over any desired period and would prevent a depressed price at the peak of a season. Fruit processing and canning plants can be established to conserve the surpluses for off-season use.

As the development of a sound fruit and fruit products industry will require several years, the establishment of any commercial-sized fruit processing plant should be deferred until the production can sustain it. It is recommended that these plants be included in the long-range program.

(35) Fisheries and Seafood

(a) The market. Fish and fish products comprise about 30% of the food budget of a typical Burmese family in Rangoon. Lack of an organized fishing and seafood industry tends to keep retail prices high. Imports are necessary to supplement the local catch, another factor contributing to the relatively high price of what should be a low-priced food item.

It is estimated that imports represent approximately 76% of consumption. Imports for 1951–52 (9,060 tons valued at K2,34,43,060) were the largest since 1939–40.

Difficulties of distribution and lack of income largely restrict consumption to the coastal perimeter. It is estimated, on the basis of 19,000,000 population, that nation-wide consumption will not exceed 200,000 tons annually or 23·6 pounds per capita. As a comparison, Japanese per capita consumption is 75 pounds. Means are not available at present to establish a more accurate estimate of the probable ultimate demand.

In addition to the lack of any organized fishing and seafood industry in either processing or catching, there are no shore facilities of any consequence to handle, preserve or process fish or seafoods, nor are there any proper distribution facilities to insure that fresh fish or seafoods reach interior consumers in edible condition.

(b) Possibility of domestic production. (1) The deep-sea fishing industry in Burma at the present time is carried on by a small fleet of privately owned trawlers operating out of Tenasserim ports, principally Mergui. The fishing grounds that appear to be the most productive are the waters around the Mergui Archipelago. Japanese fishing vessels are said to have operated profitably along the Tenasserim coast prior to and during the war. Some Japanese maps indicate that tuna are to be found in the coastal waters of Burma at certain seasons of the year. Statistics on the extent of salt water fishing, the types of fish caught, and the location of the most productive fishing grounds are meager. A part of the local catch is taken from the inland rivers.

Existing trawlers are not equipped with cold storage facilities nor are shore facilities available for freezing or canning fish. Most of the catch is sold fresh in the coastal markets, and any surplus that may be left is dried or salted.

(2) The project would comprise:

1 Fishing fleet
1 Tuna cannery
1 Fish meal and fish oil plant
3 Cold storage plants.

Labor for all phases of the industry would have to be trained. It is understood that an arrangement is being made with a Japanese firm to furnish vessels and training crews for a trial period before entering into a joint venture. Such an arrangement would provide for training personnel at all levels.

(c) Economic feasibility. (1) A project report in which capital and production costs have been detailed for the fishing industry has been completed.

The capital cost for the program is estimated at:

1 Fishing fleet unit	K36,87,500
1 Tuna cannery	7,07,750
1 Fish meal and fish oil plant	4,27,500
3 Cold storage plants	33,77,250
Total estimated cost	K82,00,000

Of the total, the equivalent of K51,11,000 will be required in foreign exchange, the balance, K30,89,000, will be in local currency.

(2) *Production costs.* Production costs have been estimated for the four units comprising the industry and are summarized.

		Total Per Year	Average Cost per Long Ton
		K	K
(*a*) Fishing Fleet			
Cost of production		29,10,000	97.00
Gross sales—raw fish		1,73,88,000	579.60
Gross profit		1,44,78,000	482.60
(*b*) Cannery			
Cost of production		29,30,000	—
Gross sales—canned fish		45,00,000	3,000.00
Sales of offal		30,000	20.00
Gross sales		45,30,000	—
Gross profit		16,00,000	—
(*c*) Fish Meal, Fish Oil			
Cost of production		6,17,950	—
Sale of fish meal		4,18,000	—
Sale of fish oil		3,25,500	—
Gross sales		7,43,500	—
Gross profit		1,25,550	—
(*d*) Cold Storage Plants			
Receipts from fish storage	K1,08,00,000		
Rental of space	14,00,000		
		1,22,00,000	—
Operation cost		79,60,000	—
Gross profit		42,40,000	—

Summarizing the above:

Unit	Products	Expenditure	Income	Gross Profit
		K	K	K
Fishing Fleet	30,000 tons fish	29,10,000	1,73,88,000	1,44,78,000
Cannery	1,500 tons canned fish 1,500 tons offal	29,30,000	45,30,000	16,00,000
Fish Meal Oil	418 tons meal 46,500 gals. oil	6,17,950	7,43,500	1,25,550
Cold Storage	9,000 tons frozen fish plus rental for 1,500 tons fruit, vegetables, dairy products and meats	79,60,000	1,22,00,000	42,40,000
	Total	1,44,17,950	3,48,61,500	2,04,43,550

The difference between current wholesale prices and the estimated costs is K2,04,43,550 per year. This represents the savings to the people as a whole if these products be sold at cost.

c. The Myingyan Industrial Group

The development of the Kalewa coal mine and riverine transport system for hauling coal will make it desirable to establish an industrial center in the middle Irrawaddy Valley close to the fuel supply, and within easy hauling distance of the Shan Hills and Kachin mineral areas. A location near the confluence of the Irrawaddy and Chindwin Rivers offers the best access by all modes of transport.

A site near the city of Myingyan originally recommended as the most desirable because of the availability of river transport, railway and highway facilities has now been found subject to overflow during flood stage of the river. A more suitable site for industrial development has therefore been selected in the vicinity of Nangate on the east bank of the Irrawaddy River, opposite Pakokku where the ground surface is well above flood stage.

For the development of this proposed site there have been recommended a steam power plant fired with Kalewa coal, a zinc smelting and refining plant, a sulphuric acid manufacturing plant, and a fertilizer plant, all of which industries are interdependent, and require coal as the basic material.

Future development in this vicinity of other industries based on processing agricultural, forest, and mineral raw materials will be advantageous to the general economic improvement of central Burma.

The Myingyan area is used broadly in this Report to include a considerable part of central Burma tributary to the site. Short extensions of the existing railway and highway would be necessary to serve this site.

(36) Limestone

As far as is known, there are no commercial limestone quarry and crushing plants in the Myingyan area. Limestone is known to exist in both mountain ranges forming the east and west rims of the great central basin of Burma, and has been found near Myingyan.

While little concrete work is now being done, a great deal will be done in this area in executing the industrial development plan. Some of the aggregate required can be granite, which is also available in this region.

Railroad ballast and highway metal will also be required in substantial quantities. Because of the lack of an adequate market at present it will be best to produce the current requirements by means of small crushing and screening plants located where suitable deposits exist near market areas.

When the industrial group at Myingyan is approved and construction is started, a crushing plant for concrete aggregate must be established as close to the plant site as is possible. A self-contained portable crushing and screening plant, using manual labor for loading rock, may be purchased for about $35,000 (K1,65,200).

This plant may be included as a part of the construction cost of all of the Myingyan projects, or it may be set up as a separate unit.

Limestone of good quality is available at Thayetmyo in the quarry of Burma Cement Company, Limited. However, a screening plant would have to be installed at Thayetmyo to segregate crushed rock by sizes, before it would be available from that source. The production of agricultural lime in this area must be included in the industrial plan.

(37) Lime

The lime requirements of Burma have previously been discussed under Projects 1- a- (3), and 1- b- (29). It is the purpose here to explore the possibility of manufacturing lime in the Myingyan area.

The nearest known active limestone quarry operation is that belonging to Burma Cement Company, Limited, at Thayetmyo. Here are ample deposits of high calcium carbonate limestone that are believed to be suitable for the manufacture of quicklime and hydrated lime. The organization and management skills and many of the facilities that would be required are available, and lime could be manufactured at Thayetmyo with a minimum investment.

Quicklime can be manufactured in the Portland cement plant by the addition of suitable equipment. At present, however, the capacity of the Thayetmyo plant is not sufficient to supply the current demand for Portland cement, so the present facilities should not be used for the manufacture of lime. Consideration is being given to enlarging the capacity of the Thayetmyo plant, as it is estimated that the demand for Portland cement will at least double in the next ten years. If this is done now, as it should be, to supply the anticipated requirements for cement, there may be some idle capacity that will permit the manufacture of quicklime with a minimum of capital investment. Later, when all of the capacity can be utilized for Portland cement, new lime-burning equipment may be added.

To explore the economies of manufacturing lime at Thayetmyo on a part capacity basis, some assumptions must be made: both Portland cement and lime could and would be made simultaneously, one half of the capacity of a second kiln would be utilized for burning lime, the present limestone quarry would be madernized and mechanized, and a screening plant would be a part of this improvement. To burn limestone in a rotary kiln only a single size gradation of limestone must be used at one time. This can only be obtained by screening. A fourth assumption would be that natural gas would be available for both Portland cement and lime burning. On these assumptions, estimated costs have been prepared which are shown in Table XXII–30 (*see next page*).

These estimates indicate that Portland cement costs are not affected by the manufacture of lime on a part-time basis. The unit cost of K53.91 per long ton compares to K53.31 when operating full time on cement.

The estimated cost of quicklime on this basis is K54.27 per long ton compared to K96.62 for a separate lime plant in Rangoon (see Project 1- b- (29)). The estimated cost of hydrated lime made at Thayetmyo compares K72.22 per long ton with K[illegible]4.39 when made at Rangoon. Thus lime made at Thayetmyo using cheap natural gas can be shipped to Rangoon, or to Akyab, and sold cheaper than lime made at Rangoon.

The increase in investment cost at Thayetmyo, to make lime, is small, being about K9,44,000. The per cent return on the investment remains about the same as if the Thayetmyo plant were to be operated entirely on cement.

However, if the lime is not manufactured as a part-time enterprise, the costs at Thayetmyo would increase if the second (new) kiln were idle part of the time. It may therefore be concluded that the Thayetmyo plant is the most economical manufacturing point for lime in Burma.

(38) Portland Cement

The subject of Portland cement has been covered in Project 1- b- (28), and in a separate project report.

It is a matter of economics and of policy whether the additional manufacturing capacity required to meet the growing needs of Burma is to be obtained by means of increasing the capacity of the plant of Burma Cement Company, Limited, at Thayetmyo or by the construction of a new plant at Rangoon.

The economic factors indicate that the required new capacity may be obtained more cheaply by enlarging the existing plant at Thayetmyo.

(39) Natural Gas Products

The production of natural gas by petroleum companies in Burma is discussed in Chapter XXI, Mineral Industries. If an ample supply of this fuel becomes available, it may then be feasible to manufacture carbon black, which is required by the rubber tire and paint industries.

TABLE XXII-30

ESTIMATED MANUFACTURING COST, COST OF SALES, AND PROFIT

Thayetmyo Plant ¾ Cement—¼ Lime

Item	*Annual Cost Cement (K) 90,000 L.T.*	*Cost per L.T. (K)*	*Annual Cost Quicklime (K) 15,000 L.T.*	*Cost per L.T. (K)*	*Annual Cost Hydrated Lime (K) 10,000 L.T.**	*Cost per L.T. (K)*
1. Operating and Repair Labor	2,40,000	—	40,000	—	20,000	—
2. Operating and Repair Supplies	3,20,000	—	60,000	—	20,000	—
3. Limestone—Cement	2,25,000	—	—	—	—	—
4. Limestone—Lime	—	—	75,000	—	—	—
5. Silica Sand	18,000	—	—	—	—	—
6. Gypsum	3,06,000	—	—	—	—	—
7. Power	2,90,000	—	40,000	—	30,000	—
8. General Works Expense and Cont. and Royalty	4,80,000	—	80,000	—	40,000	—
9. Fuel Cement	1,80,000	—	—	—	—	—
10. Fuel Lime	—	—	30,000	—	—	—
11. Depreciation Cement	7,39,200	—	—	—	—	—
12. ,, Lime	—	—	1,38,600	—	93,400	—
13. Reserve for Gas Wells	80,000	—	20,000	—	—	—
14. Insurance	80,000	—	15,000	—	5,000	—
15. Depletion	—	—	—	—	—	—
16. Reserve Bad Accounts	4,800	—	600	—	600	—
17. Sales Commission and Expenses	2,70,000	—	45,000	—	45,000	—
18. General Administration and Overhead	67,500	—	11,250	—	11,250	—
19. London Office }	30,000	—	5,000	—	5,000	—
20. Rangoon Office }						
21. Directors' Fees	4,050	—	675	—	675	—
22. Staff Bonuses	15,000	—	2,500	—	2,500	—
23. Cost of Sales less Sacks	33,49,550	—	5,63,625	—	2,73,425	—
Less (Quicklime to Hydrate Plant)	—	—	−2,81,813	—	+2,81,813	—
24. Adjusted Cost of Sales less Sacks	33,49,550	—	2,81,812	—	5,55,238	—
25. Cost of Sacks	15,03,000	—	1,25,250	—	1,67,000	—
26. Gross Cost of Sales	48,52,550	53.91	4,07,062	54.27	7,22,238	72.22
27. Gross Sales	1,57,50,000	175.00	10,92,000	145.60	15,22,668	152.26
28. Less Freight and Warehousing—Rangoon	18,72,000	20.80	1,56,000	20.80	2,08,000	20.80
29. Net Sales	1,38,78,000	154.20	9,36,000	124.80	13,14,608	131.46
30. Less Cost of Sales	48,52,550	53.91	4,07,062	54.27	7,22,238	72.22
31. Gross Profit	90,25,450	100.29	5,28,938	70.53	5,92,370	59.24
32. Less 50% Income Tax	45,12,725	50.14	2,64,469	35.27	2,96,185	29.62
33. Net Profit	45,12,725	50.15	2,64,469	35.26	2,96,185	29.62
(Quicklime)	2,64,469	—	—	—	—	—
(Hydrated Lime)	2,96,185	—	—	—	—	—
34. Total Net Profit	50,73,279	—	—	—	—	—
35. Capital Invested	1,36,94,500	—	—	—	—	—
36. Return on Investment	37·1%	—	—	—	—	—

*7,500 L.T. of quicklime becomes 10,000 L.T. of hydrated lime when water is added.

(40) and (41) Petroleum and Zinc

These projects were included in the master chart as sources of materials and products required by various industries. The reports on these two industries are included in Chapter XXI, Mineral Industries.

(42) Sulphuric Acid

(a) The market

(1) *General requirements*

Burma would use over 3,000 tons of sulphuric acid per day to produce sufficient superphosphate and ammonium sulphate fertilizer to cover its rice land.* At the present time, Burma's consumption is approximately one ton of sulphuric acid a day.

The leading and most heavily used basic chemical in the world today is sulphuric acid. It is used in chemical reactions for the manufacture of pharmaceuticals, paints and pigments, formic acid for the coagulation of raw rubber, insecticides, dyes, iron and steel pickling, petroleum refinery processing, sodium phosphate, nitric acid, phenol, and many other chemicals. The needs for sulphuric acid lie, therefore, first, in consideration of the agricultural program for the production of fertilizers, and second, in laying the foundations for modern industry.

(2) *Access to the market*

The largest need for sulphuric acid is in the manufacture of superphosphate and ammonium sulphate fertilizer which will constitute 98·5% of the immediate market. The sulphuric acid plants should be located as closely as practicable to these two fertilizer plants. Myingyan has been considered as the site for these industries inasmuch as it is centrally located in Burma with respect to availability of cheap power, cheap coal, raw materials, rail and water transport. Good railway connections are available north to Mandalay, south to Rangoon, northeast to Lashio, and southeast to the southern Shan States. Water transport is available as the location is near the junction of the Chindwin and Irrawaddy Rivers. Power availability is included in plans for construction at Myingyan of a coal-generated electric power plant to produce 20,000 kilowatts.

(b) Possibility of domestic production

(1) *Cost of imported sulphuric acid*

Import costs are out of all proportion to the manufactured value of sulphuric acid. This high import cost is due to the excessively high cost of transport which in turn is due to the special handling required by the acid, special care, special containers, high cost insurance, high cost freight, high risk, and because it represents both bulk and weight at a proportionally low value. The following Table XXII-31 illustrates the estimated price differential between sulphuric acid manufactured in Burma and imported sulphuric acid.

TABLE XXII – 31

SULPHURIC ACID (H_2SO_4) PRICE DIFFERENTIALS

Plant Designation	*Sulphuric Acid Manufactured from:*	*Price of Sulphuric Acid*		
		*Burma Manufactured Cost**	*Imported Sulphuric Acid at Myingyan*	*Increase Per cent*
Plant "A"	Zinc Smelter Gases, Sulphur Dioxide (SO_2) (50·9 tons H_2SO_4/day)	K96.31 per ton	K596.22 per ton	20
	Imported Bulk Sulphur (83·1 tons H_2SO_4/day)	K182.74 per ton	K596.22 per ton	26
Plant "B"	Imported Bulk Sulphur (342 tons H_2SO_4/day)	K154.11 per ton	K596.22 per ton	[illegible]
Plant "A" and "B" Average		K144.39/ton	K596.22/ton	[illegible]

*As per 100% sulphuric acid.

(2) *Input materials and utilities*

The proportion of input materials and utilities required per ton of manufactured sulphuric acid is very small. The electric requirements are minor; the man-hours of labor are low; less than one gallon of water is required per one pound of sulphuric acid; the outstanding consideration is the availability and cost of one third ton† of imported bulk sulphur for each ton of sulphuric acid. A list of the utilities and materials required to produce one ton of 100% sulphuric acid by the contact process is given in Table XXII-32.

TABLE XXII – 32

MATERIALS REQUIRED PER TON OF SULPHURIC ACID MANUFACTURED

(Contact Process)

Type of Material, Utility, or Service	*Amount of Materials Required per Ton of Manufactured Sulphuric Acid (2240 lbs.)*
Sulphur	770 pounds
or Sulphur Equivalent	9% Sulphur Dioxide Gas from Smelter
Air	280,000 cu. ft.
Water	1,870 gallons
Steam‡	224 pounds
Electricity	5·6 kWh
Labor	1·143 man-hours

‡Furnished by waste heat boiler or heat exchanger.

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*At one ton each of superphosphate and ammonium sulphate fertilizer per every 11·2 acres of rice.

†0·344 tons sulphur to one ton of sulphuric acid.

(3) *Direct and indirect employment*

The number of personnel necessary to operate the sulphuric acid plant is comparatively small. Much of its operation is automatic and the plant is unusually compact. In regard to indirect employment, the production of sulphuric acid is far-reaching. The use of fertilizer will increase farm labor requirements for its application and for harvesting the heavier crops. A corresponding increase will develop in processing facilities for rice, cotton, tobacco and other produce. In the manufacture of industrial products such as steel, chemicals, paper, textiles, paints and petroleum, the use of sulphuric acid will increase the productive employment of many thousands of people.

(4) *Skilled workers*

The sulphuric acid plant does not need a large number of skilled workers. The plant manager, plant chemist and supervisor for each shift (3), are the only personnel who require a special technical background. The plant manager, and possibly the plant chemist, should be European trained with a chemical engineering background. The remainder of the personnel will receive further training and directions under their supervision.

(5) *Foreign exchange conservation*

The amount of foreign exchange conserved by the manufacture in Burma of the 142,800 tons per year of sulphuric acid required by the combined yearly production of 277,500 tons of superphosphate and ammonium sulphate fertilizers is K6,40,00,000 per year or approximately 300%* of the price required to manufacture the amount in Burma. The complete saving resulting from the use of domestic fertilizer in lieu of imported fertilizer is brought out in the presentation of project 42.

(c) Economic feasibility

(1) *Description of plant*

Two sulphuric acid plants are recommended. One plant, referred to as Plant "A," is a medium-sized plant with a 134 ton/day capacity of which 127 tons will be utilized in the production of superphosphate fertilizer and the remaining seven tons in the manufacture of other industrial requirements. This plant will be located directly adjacent to the proposed Myingyan zinc smelter and will utilize the zinc sulphide waste fumes† for the production of one third of its total sulphuric acid output. This section of the plant is referred to as Plant Section I of Plant "A." The remaining two thirds output of sulphuric acid will draw its raw material supply from imported bulk sulphur, and this section of the plant will be referred to as Plant Section II of Plant "A."

The second plant, referred to as Plant "B," is a large plant with a 342 ton/day capacity which will be utilized entirely in the production of ammonium sulphate fertilizer. This plant will use imported bulk sulphur as a raw material and will be located as close as possible to the ammonium sulphate plant which it serves. Its use of imported sulphur as a raw material will enable it to be located at any particular site convenient to the ammonium sulphate plant whether this be Myingyan or some location closer to Rangoon.

(2) *Raw material cost, production cost and earnings*

In Table XXII–33, the "Sulphuric Acid Project Master Chart," various operational phases are shown which affect the economies of Plant "A" (Section I and Section II), Plant "B," and both plants totaled or averaged together. Production costs, raw material costs and earnings are shown for all plant sections. Earnings have been represented as the difference between production cost and the estimated cost of sulphuric acid imported at Myingyan.

The difference between the production cost of sulphuric acid manufactured in Burma and the imported cost of sulphuric acid at Myingyan is K2,14,100 per day for 476 tons; or, for one year of 300 working days, an equivalent gain of K6,42,30,000. Against this "gain" of over six crores, the required capitalization is very small at K1,90,87,528.

(d) Existing production facilities. At the present time, no sulphuric acid is being produced in Burma. Prior to the war, the Burmah Oil Comany (BOC) had two sulphuric acid plants of 20-ton-per-day capacity each. Both plants were designed to operate 24 hours a day throughout the year, but due to a limited demand were working at half capacity and produced only ten tons per day each. The plants were almost completely destroyed and dismantled during the war. The reconstruction of these older plants (1929) has not been considered practical as the design of modern plants is so much more compact and economical. Both plants employed the contact process using imported sulphur with a SO_3 conversion efficiency of 94% and an over-all efficiency of 88% to 90%. The acid produced was 95% strength with a specific gravity of 1·8407 at 15·56° C.

Under the present refining policy, no sulphuric acid is used by the Burmah Oil Company and none is planned. Prior to the war, sulphuric acid was used solely for refining products as BOC had no cracking process equipment.

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*Refer to Table XXII–31 "Sulphuric Acid Price Differentials."

†Will utilize total zinc sulphide ore concentrates available. Resulting sulphur equivalent is: 60·3 tons/day ZnS × 29% sulphur = 17·5 tons/day sulphur.

TABLE XXII – 33

SULPHURIC ACID (H_2SO_4) PROJECT MASTER CHART

Basis of Plant Operation		*Unit*	*Plant "A" 134 ton/day* *Plant Section I* *Zinc Smelter Fumes*	*Plant "A" 134 ton/day* *Plant Section II* *Imported Bulk Sulphur*	*Plant "A" Subtotal (Average)*	*Plant "B" 342 ton/day* *Imported Bulk Sulphur*	*Plant "A" and "B" Subtotal (Average)*
Sulphur Equivalent used as Raw Material		Tons/day	17·5	28·6	46·1	117·6	163·7
Cost of Raw Material (at Myingyan)		K/ton	70	383	227	383	305
		K/day	1,225	10,930	10,470	41,200	49,500
Amount of Sulphuric Acid Manufactured		Tons/day	50·9	83·1	134·0	342	476
Production Cost		K/ton	96.31	182.74	139.53	154.11	146.82
		K/day	4,895	15,200	18,700	52,700	69,500
Equivalent Cost of Imported Sulphuric Acid (at Myingyan)		K/ton	596.22	596.22	596.22	596.22	596.22
		K/day	30,300	49,500	79,800	2,04,000	2,84,000
Difference between Production Cost and Imported Cost (Earnings)		K/ton	499.91	413.48	456.69	442.11	449.40
		K/day	25,405	34,300	61,100	1,51,300	2,14,100
Percentage Difference between Manufacturing Cost and Import Cost		%	520	226	327	286	306
Plant Cost		K	47,62,986	41,24,542	88,87,528	1,02,00,000	1,90,87,528
Ammonium Sulphate Fertilizer from Sulphuric Acid*	Ammonium sulphate produced	Tons/day	nil	nil	nil	450	450
	Sulphuric acid required	Tons/day	nil	nil	nil	342	342
Superphosphate Fertilizer from Sulphuric Acid†	Superphosphate produced	Tons/day	189	286	475	nil	475
	Sulphuric acid required	Tons/day	50·9	76·1	127	nil	127
Explosives and Industrial Manufactures from Sulphuric Acid	Explosives and Industrial Manufactures produced	Tons/day	nil	150	150	nil	150
	Sulphuric acid required	Tons/day	nil	7	7	nil	

*0·760 ton H_2SO_4 = 1 ton ammonium sulphate.
†0·268 ton H_2SO_4 = 1 ton superphosphate.

(e) Recommendations

(1) *Expenditure schedule*

Out of a cost of K1,90,87,528 for both sulphuric acid plants "A" and "B," the amount required for foreign currency expenditure is 72%, or K1,38,30,446. This will include all machinery, chemical equipment, transport to Burma, and engineering services and supervision.

Local capital requirements will constitute the remaining 28%, or K52,57,082, of all expenditures. This will include buildings, land, installation charges, and further transport of equipment in Burma from Rangoon to Myingyan.

(2) *Construction schedule*

Schedules of construction will parallel those to be established by both the ammonium sulphate and the superphosphate fertilizer plants. As the production of the sulphuric acid plants will be almost entirely absorbed (98·5%) by the foregoing fertilizer plants, it follows that the actual construction of the acid plants will await disposition of final plans for the ammonium sulphate and superphosphate plants before proceeding.

With Plant "B," 100% of its 342 tons/day of sulphuric acid will go into the manufacture of ammonium sulphate fertilizer. With Plant "A," 95% of its 134 tons/day of sulphuric acid will go into the manufacture of superphosphate fertilizer. The remaining 5% will go into the manufacture of other industrial requirements.

Schedule of construction for Plant "A" will also be affected by plans for the Myingyan zinc smelting plant project. As the Plant "A" sulphuric acid plant will be built directly adjacent to the zinc smelter and will derive one third of its raw material supply for this source, it follows that plant "A" would not ordinarily go into capacity operation without the zinc smelter.

The building of the necessary sulphuric acid plants must therefore await two developments: (1) the construction of the ammonium sulphate and superphosphate fertilizer plants and (2) the construction of the Myingyan zinc smelter.

With eventual clearance of the two foregoing factors, the construction of the sulphuric acid plants will require from 18 to 24 months following delivery of equipment on location at Myingyan. The newer type sulphuric acid contact plants are unusually compact and can ordinarily be assembled rapidly, often in 12 months; but to include time for site preparation and contingencies, 24 months should be allowed.

(43) Gypsum Products

This project was included in the master plan and chart as a possible industrial project because Burma is known to have some deposits of gypsum, though no deposits of commercial significance have been discovered.

Gypsum is needed to provide sulphuric acid for the proposed fertilizer plant at Myingyan, and to avoid the necessity of importing sulphur for this purpose. A limited supply of sulphur will be available from the zinc refining plant but it will not be sufficient to support the fertilizer industry.

Gypsum can also be used to manufacture building construction and other products, such as:

Plaster of Paris	Gypsum Partition Block
Keene Cement	Gypsum Shingles
Gypsum Wall Board	Gypsum Plasters

The crude gypsum is used only for the manufacture of sulphuric acid and as a retarding agent to control the setting time of Portland cement.

When gypsum is used in the manufacture of sulphuric acid, a lime sludge residue results which is normally a waste product as it usually contains a small percentage of sulphuric acid. A better use of gypsum would be through the adoption of another process for the simultaneous production of sulphuric acid and Portland cement. In this process the additional raw materials required for the manufacture of Portland cement are fed into a rotary kiln with the proper amount of gypsum. The sulphuric acid is recovered from the stack gases, while the Portland cement clinker is discharged from the other end of the kiln. About one ton of sulphuric acid to one ton of Portland cement clinker results from this process, and there is no residual waste product.

The proposed fertilizer plant would require about 1,150 long tons of gypsum per day or 337,500 long tons per year. The present Portland cement industry uses about 2,400 long tons per year, and when its capacity is doubled the demand will increase to about 4,800 tons.

Gypsum has been found in Burma in the Myingyan area. The known deposits extend north from Thayetmyo to Chauk, on both sides of the Irrawaddy River. Crude gypsum used by Burma Cement Company, Limited, in the manufacture of Portland cement at its Thayetmyo plant is produced near Yenangyaung, 125 miles upstream from the cement plant. Other deposits have been worked near Thayetmyo and the mineral is known to exist in the Magwe area.

All of the gypsum found in Burma has been in the crystalline form. This exists in surface deposits in the form of sheets, from very thin up to two inches in thickness. It is normally covered by some overburden. As the deposits thus far discovered are thin, the cost of production is high. While existing in considerable quantity in this form over a large area, the deposits cannot be considered commercially workable.

No deposits of the solid, white-rock gypsum have been located. If a solid sheet of the crystalline gypsum extended over a single square mile and had an average thickness of one half inch, there would be available a total of 56,950 long tons per square mile. In most areas the deposit is not continuous, so the available gypsum per square mile would not be over 25,000 long tons, as an average.

The known deposits are sufficient to supply the needs of the Portland cement industry, which can afford to pay a high price for a small percentage of its raw material requirements, but no industry depending upon gypsum as its principal raw material can operate on such a basis.

The cement company pays K75.00 per metric ton delivered in its storage. The freight to the plant is K19.25 per ton. Before the war the price paid was K20.00 per ton from deposits near Thayetmyo.

BOC has drilled the area on the west bank of the Irrawaddy. A check of the well logs does not reveal any lower deposits of rock gypsum. The Burma Geological Department has no information on any deposits other than the surface deposits described previously in this Report.

As this is the "arid" section of Burma, a water well drilling program is being implemented to provide water for the villages. Every effort should be made to check the logs of each well drilled to determine if any gypsum deposits exist. If this does not reveal such deposits, then a core-drilling program should be organized to drill test holes elsewhere, or at lower levels than required for water wells. This mineral is important to the economy of Burma and an extensive exploration program to find commercial deposits is justifiable.

(44) Fertilizer

(a) The market. The need for fertilizer in Burma is large. No substantial amount of fertilizer has been used in the country, and over a long period of years a depletion of the chemicals of the soil necessary for the growth of foodstuffs, particularly rice, has occurred. Natural fertilizers or soil conditioners such as rice bran have been used but not on a large scale. None of them supply the amount of nitrogen urgently needed and recognized as necessary to prevent the continual depletion of the soil and the further reduction of the yields per acre of crops, especially rice.

Phosphorus is also recognized as a necessary fertilizer material in many locations although it is not held to be universally required. It is used as a supplement to nitrogen which is applied to the soil in the form of ammonia or ammonia compound.

Potash, the third usual principal fertilizer material, is not regarded as of prime essentiality. It could be added, as could also other trace elements, if soil conditions demand in a program of producing balanced or complete fertilizer products. In any case, potash will have to be purchased from overseas in its finished form as such and will not require processing.

For Burma, the essential ingredient of fertilizer manufacture is ammonia, since rice, the principal crop, responds best to this compound. Phosphorus is an important secondary material in the balanced fertilizer for rice application.

The factories proposed will have annual capacities of 42,900 tons of ammonia and 157,000 tons of superphosphate. These capacities are estimated to be about 10% of the country's potential need. Entire production is intended for domestic use. The Government would be the principal monetary beneficiary of the increased agricultural production that fertilizer will make possible.

(b) Possibility of domestic production. (1) The fertilizers considered for domestic manufacture are urea and ammonium sulphate. The estimated production cost for urea bagged and ready for shipment is K325 per ton and K248 for ammonium sulphate. The selling price of urea in these countries where it is available is equivalent to about K700 per ton. Likewise, the mill cost of ammonium sulphate is attractive when compared with selling prices elsewhere in the world. If a fertilization program on a national scale is adopted, on the basis of production costs, the manufacture of those components for which the raw materials are available in the country should be undertaken. It will be necessary to import phosphate rock for superphosphate, the manufacture of which is simply a treatment with sulphuric acid.

(2) The principal raw materials required are coal, air, electricity and sulphur in their element form or as compounds such as gypsum or sulphur-bearing metallic ores.

As a chemical enterprise, the manufacture of fertilizer has many variations depending on the raw materials which are available to produce the desired final products. Some fertilizers, particularly ammonia compounds, may compete among themselves for the same market. Hence, a careful evaluation of costs of production based on different raw materials and different end products is essential.

As a matter of practical application to crops, it is necessary that ammonia be in solid form which may be either urea or ammonium sulphate. Urea is advantageous, particularly in Burma, since it does not require the use of any form of sulphur—a relatively scarce commodity. All of the ammonia produced may be converted to urea by recycling, a process that is relatively expensive. A simpler process which converts only part of the ammonia into urea is recommended instead. The unconverted ammonia is then made into ammonium sulphate in simple and cheap equipment (provided a source is available), rather than being recycled. While there are many aspects which make the complete conversion of all ammonia to urea desirable, even by the more expensive recycle process, it is not recommended for this first fertilizer project; instead it is recommended that only the simple process be used on a "once through" basis, and the balance neutralized to give ammonium sulphate. Some sulphur probably will be available later from zinc smelting operations, but the quantity will be relatively small in comparison to requirements, making sulphur importation necessary.

Ammonium nitrate is another apparently advantageous solidified form of nitrogen which has been considered. It is not recommended, even though it requires no sulphur, since it presents some explosive hazard in handling, and its efficiency in rice culture is questionable.

(3) Two fundamental methods for making ammonia have been considered. Estimates of costs and analysis of advantages have been made for each process.

The first of these methods for producing the necessary synthesis gases, hydrogen and nitrogen, for the production of ammonia would utilize coal from Kalewa as the prime ingredient, together with air and water. The recommended location for such a plant is just below Myingyan at the location of a proposed industrial center.

The second method would utilize large amounts of electric power which must be made available at a cost of about one pya per kilowatt hour when balanced against the cost of Kalewa coal.

The detailed analysis (see project report under preparation) indicates the coal process as most advantageous. Comparison of the two methods is too complex for detailing in the space of this section.

(4) With due consideration of all factors including the probable time necessary to make available the cheap electric power and the relatively high cost of the electrolysis plant, it is recommended that the method utilizing approximately 470 long tons per day of Kalewa coal be adopted and that a plant be built near Myingyan for the synthesis of 130 long tons per day of ammonia. Adjacent to and as a part of the synthesis plant would be factories with all utilities and accessories for the production of 90 long tons of urea per day on a "once through" basis; of 450 long tons of ammonium sulphate a day (estimates are made for production from either sulphuric acid or from gypsum); of 475 tons per day of superphosphate; of 50 tons per day of mixed fertilizers; and of adequate sulphuric acid, steam and electric power supplies.

Some small part of the anhydrous liquid ammonia, which would be made in the amount of 130 long tons, per day, may be utilized also for the industrial and refrigeration needs of the country. Assuming that only about ten tons per day would be so utilized, 450 long tons a day of ammonium sulphate will be produced. Alternatively, if urea is made by the "once through" process, some 90 long tons per day will be produced; and the balance will be utilized to give some 300 long tons of ammonium sulphate per day.

A plant for utilizing almost the entire production of ammonia as ammonium sulphate is therefore recommended. This requires sulphuric acid manufactured from imported sulphur or from zinc sulphide smelting and the sulphur oxides so produced. Alternatively, gypsum may be used to produce ammonium sulphate; but known sources of the mineral would be inadequate to supply demand. Adequate amounts should be found if careful explorations are instituted in the area now supplying gypsum for the cement plant at Thayetmyo. However, a producing plant for ammonium sulphate utilizing gypsum as a source of sulphur has been outlined and estimated. It is recommended that it be used as an alternative to the ammonium sulphate project if and when adequate supplies of gypsum are proven.

In addition to ammonium compounds, phosphorus is also required as a fertilizer material; the usual form being superphosphate made from phosphate rock. No phosphate rock is known to be available in Burma although no adequate non-metallic minerals survey of the country has ever been made. It is recommended that phosphate rock be imported and that a plant be built to produce 475 long tons of superphosphate per day. This amount, from the standpoint of utilization on crops, will balance roughly the ammonia fertilizer that will be produced.

Required sulphuric acid may be made from imported sulphur, from sulphuric oxides resulting from zinc smelting or from gypsum. The material selected for the initial installation is imported sulphur, although costings have been made for the acid from zinc smelting.

Lastly, a fertilizer mixing plant is required to prepare the complete product for utilization by the cultivator. This is merely a compounding or blending station. It may well be located also at the Myingyan fertilizer center for convenience in manufacture and distribution. Additional mixing plants may be built at other locations near the center of agricultural lands utilizing the fertilizer itself. It is recommended that a mixing plant at Rangoon be built immediately to make possible a major demonstration and educational program which will, by itself, be quite profitable. It would use domestic additives and foreign ammonium sulphate and superphosphate at first, and later the products of the domestic fertilizer plant.

(5) As with other projects in the industrial development scheme, labor will have to be trained under foreign management for a period of years. Counterpart local management also will receive training in a gradual taking-over process. The project will afford direct employment to some 400 people in all categories.

(c) **Economic feasibility.** (1) Estimated costs of plants comprising the initial industry are:

	Foreign Exchange Equivalent	*Domestic Currency*	*Total*
	K	*K*	*K*
(*a*) Ammonia	5,17,75,000	1,68,62,000	6,86,37,000
(*b*) Urea	1,20,88,000	32,77,000	1,53,65,000
(*c*) Ammonium Sulphate	53,20,000	34,67,000	87,87,000
(*d*) Superphosphate	20,18,000	20,66,000	40,84,000
(*e*) Mixed Fertilizer	14,01,000	21,37,000	35,38,000
Total	7,26,02,000	2,78,09,000	10,04,11,000

Cost of ammonium sulphate plant using gypsum is K1,85,25,000. This plant is not recommended for the initial installation.

(2) To arrive at over-all profitability and to simplify calculations, only ammonium sulphate and superphosphate will be considered as total end products. Because of the lower price per ton of fixed nitrogen in urea, its consideration would show a greater profit than that demonstrated here.

(3) *Annual Production Costs*

150,000 long tons ammonium sulphate (31,500 tons nitrogen)	K3,27,00,000
157,000 long tons superphosphate (33,000 long tons P_2O_5)	K2,75,00,000
Total cost per year including amortization	K6,02,00,000
Cost of transportation, distribution, use and handling of increased yields of rice assumed at two thirds of production cost	K4,00,00,000
Total national cost of fertilization	K10,02,00,000

(4) The original assumption in developing the capacities of the plants suggested was that one tenth of the average land might be fertilized with a more or less average dosage. On the other hand, the maximum gains from a given amount of fertilizer would be obtained by fertilizing land with present subnormal yields of rice with a lower dosage. The maximum profit would depend on balancing several economic factors which are very difficult to compute.

For the purpose of this simple calculation, assume that lands are selected having relatively lower than average present yields, say in the range of 1,000 pounds paddy per acre per year. Experiments on such lands have shown increases of over 100% in the production of rice by using an equivalence of 20 pounds nitrogen plus 20 pounds superphosphate per acre.

On such a dosage, the nitrogen and phosphate fertilizer available would serve to enrich a total of 3,500,000 acres.

Production yield increases established by the use of these relatively low dosages of fertilizer are first year increases which probably may be bettered somewhat until the land reaches its optimum with continuous dosage. The point of optimum yield has not been established and need not be considered here. A conservative 430 pounds of paddy, taken as the increment resulting from fertilizer use, will lose about 30% of its weight in producing rice products, mainly polished rice. Neglecting any monetary value of this 30%, a recovery is obtained equivalent to 300 pounds of polished rice as the increment per acre due to the use of fertilizer. This amounts to 1,050,000 pounds for the land fertilized or roughly 470,000 long tons of increased rice production at a cost of K10,00,00,000 or K213 per ton.

If this increased rice production is sold at the present export average price of K800 per ton, there will be an increased revenue to the Government of K27,50,00,000. The cost of this increase is K10,00,00,000; the apparent profit is K17,50,00,000 or a return of about 175% on the investment.

D. RECOMMENDATIONS

After completing the study of the entire industrial development program outlined for the Union of Burma, after considering the immediate and future needs of the projects not included in this industrial section, and after studying the immediate and future needs of the nation as a whole, it is evident that each industrial project can be placed in one of several categories.

It was found that certain products to be manufactured in certain of the projected plants were basic products that were critically needed to implement the economic and industrial development program, or to conserve foreign exchange, or both. The plants to manufacture these basic products were placed in an initial program with the recommendations that these projects be implemented immediately. This initial program has been called the "First-year Plan."

Other products less critical to the implementation of the program, or the manufacture of which depends upon one or more of the products of the plants included in the First-year Plan, were placed in a secondary group of projects for construction at a later date. This secondary grouping has been called the "Intermediate Program."

The balance of the projects have been placed in a third group for future study, action and implementation. Some of these cannot now be considered for construction due to insufficient information or due to lack of suitable known sources of raw materials. Others have been deferred because the present or immediate future market studies indicate that the demand for the products of these plants would be too small to justify a minimum sized plant to produce them. Still others are duplicate industries in separate areas that are not required now to supply the present or immediate future demands for the particular product. At a later date the initial plants will not be able to supply the anticipated demands outside of the area in which they are to be located. At that time the duplicate plants should be established in other regions to reduce transportation costs. This grouping has been called the "Long Range Program."

In dividing the projects into the three groups, consideration was given to the wishes of the government officials, to the ability of the Government of Burma to finance the program out of surplus revenue, and to the availability of national managerial and technical talent of the types required.

1. FIRST-YEAR PLAN

This initial program has been carefully worked out after consultation with the government officials. Prior to the completion of this Report a separate condensed report was submitted in which this First-year Plan was presented. This separate report included recommendations covering the entire economic and development program, as well as industrial projects.

The industrial projects included in this First-year Plan report were the following:

(*a*) A steel products plant.
(*b*) A joinery plant.
(*c*) Expansion of Portland cement manufacturing facilities.
(*d*) An asbestos-cement products plant.
(*e*) A rice bran oil extraction plant.
(*f*) A jute textile and bag plant.
(*g*) A bamboo paper pulp and paper factory with supporting chemical plants.
(*h*) An ammonia-based fertilizer plant.

It will be noted that four of the included projects are for the manufacture of construction materials. These are amply justified by the heavy construction program planned in implementing the economic and industrial development program. A fifth construction material project covering clay roofing tile and clay brick has not been included because the machinery and equipment has already been ordered. It need only be considered in totaling the financial requirements for the industrial program. Additional projects to be added to this group would be a pharmaceutical plant, as this has been advanced to this classification recently, and a fishing and a sea products industry. The balance of the projects forming the First-year Plan are basic industries to manufacture products now being entirely imported, and which are essential to the economy of the Union of Burma.

The number of these projects is approximately all that should be implemented at one time considering the financial and management resources of the nation. It is recommended that all of these be implemented as early as possible.

It is believed that all of these projects may be placed in operation within a period of from one to four years. The First-year Plan may then be considered to cover an initial period of about four to five years.

2. INTERMEDIATE PROGRAM

The study of the basic plan indicates that certain other industries should be established as soon as possible after the First-year Plan industries have been implemented. Basically these should follow during the second five years, although there can be and should be some overlapping toward the end of the First-year Plan time period in order to insure a continuity of the development plan.

The industries that should be included in this intermediate plan period are the following:

a. Akyab District

(1) Calcium carbide and vinyl plastic plant.
(2) Paper bag plant.

b. Rangoon District

(3) Additional cotton spinning and weaving factory capacity.
(4) Cotton bleaching, dyeing and printing plant.
(5) Soya milk products plant.
(6) Additional rice bran oil extraction plants.
(7) A sugar refinery with sugar chemical plants.
(8) A veneer and plywood plant.
(9) A wood waste wallboard plant.
(10) A furniture factory.
(11) A wood waste chemicals plant.
(12) A tannin and cutch extraction plant.
(13) A paint and varnish plant.
(14) A rubber products plant.
(15) A modern lime plant.

c. Myingyan District

(16) A gypsum products plant (if commercial deposits of gypsum are located).

The intermediate plan should be flexible enough to allow for changes in the plan to meet new conditions. Certain industries that start on a small scale and do not provide self-sufficiency should be enlarged as rapidly as men can be trained and funds become available. Such industries are the cotton spinning and weaving and the rice bran oil extraction plants.

3. LONG RANGE PROGRAM

This will be an expansion period in which initially established industries will be enlarged to produce all of the requirements of Burma for the products of these plants. It will also include the establishment of other new industries as fast as they become economically justified. By-product plants of other industries will be included as the full possibilities of each raw material are explored and the need for such products can be justified. By this time such large products as rayon production, auto tire plants, mechanical rubber goods plants, etc., may become economic possibilities. If so they should be established.

E. IMPLEMENTATION PROCEDURE

No development program of the magnitude and importance of the one proposed for the Union of Burma, and in which the Government itself will directly participate to such a great extent, may be successfully implemented unless and until all of the resources of the Government are strongly in support of it and unless these resources have been thoroughly and properly organized to direct and manage it efficiently along business principles.

Of equal importance with planning the program, with selecting the industries to be developed and with financing their construction, is the procurement and training of the managerial, technical and skilled personnel to staff the new industrial enterprises. These must be provided in time to be available when the new industries are ready to be placed in operation.

The power and resources of the Government must be placed in support of the program as a matter of high policy, which must be a consistent and continuing policy as the program is a long range plan.

1. MINISTRY OF INDUSTRY FUNCTIONS

Authority to plan the program and to implement it must come from the legislature and be transmitted through the executive branch of the Government to a Governmental agency whose affairs are directed by a Cabinet officer. This procedure insures that any Union program of industrial development will receive suitable recognition in the top levels of the Union Government, and that the industrial program will be developed within the broad policies of the Government.

In the Union of Burma this has been provided by the establishment of the Ministry of Industry, whose directing head is a member of the Cabinet. The functions of such a Ministry are partly political as they must be, to insure that the political policies of the Government will be expressed in every channel through which the Government operates.

The Ministry of Industry is charged with the responsibility for promoting industrial growth to the end that the Union of Burma may be as independent as possible of imported products. It may, in the interests of national security, even promote industries that are not economically justified in order to be completely independent of imports of some critical commodities.

It is empowered to plan, finance, construct and operate industrial plants and may organize these as wholly government-owned enterprises, or as joint venture operations with private capital interests. It may also encourage private capital to develop industries.

Certain inherent disadvantages invariably become apparent when any governmental agency attempts to operate an industry. The routine governmental regulations and business methods usually hamper industrial enterprises.

2. THE INDUSTRIAL DEVELOPMENT CORPORATION

In order to overcome the disadvantages of attempting to direct the affairs of an industrial enterprise by a political governmental agency, many countries have established more or less independent industrial development corporations whenever they have embarked upon an industrial development program.

Generally such industrial development corporations are independent entities. In many cases they are empowered to plan an orderly development of industry within the nation. This is usually done by the employment of experienced consultants to make an exhaustive survey of the industrial resources of the nation and to recommend an immediate and long range program.

Such corporations are empowered to finance each project within limits established by the Government. They may wholly own such projects or may participate in the equity ownership of an industrial enterprise on any basis necessary to finance a project. They may also underwrite the securities or loans of a privately financed industrial enterprise.

An industrial development corporation of this type is generally headed by a managing director having a wide business, financial and industrial background and who is as independent of politics as is possible.

A corporation of this type usually acts as a holding company for all governmental enterprises and seldom attempts to actively direct the operation and management. Each individual project is usually established as an autonomous entity, directed by an experienced managing director who works within the budget and broad general policies established by the corporation directors. Whenever such a plan has been tried it has been successful. There is no successful record of an industry being managed efficiently by a governmental ministry.

All of this was reported in the Preliminary Report. This report recommended the establishment of a similar corporation in Burma. This recommendation was approved by the Government, and such a corporation was established by enacting "The Industrial Development Corporation Act of 1952."

Under this act a corporation was organized for this purpose. It is managed by nine directors appointed by the President of the Union of Burma. Three of the directors are members of the Cabinet. One is a representative of the Union Bank of Burma. Four others are to be men with business or financial experience. The ninth acts as the Director-General.

The Industrial Development Corporation has broad powers to initiate plans for industrial development, to finance such projects, to buy private industrial properties in whole or in part, to borrow money, issue securities, obtain foreign credits, and take any legal steps to carry out the missions with which it is charged.

It is strongly recommended that all project industrial corporations established and controlled by the Industrial Development Corporation be given full autonomous status to insure successful operation.

3. MANAGEMENT AND MANAGEMENT TRAINING

a. Importance of Training Program

The procurement of experienced top executive management to direct the new industrial enterprises is one of the most important problems to be solved in implementing the industrial development program as Burma has few men qualified to direct these organizations.

The entire subject is discussed in Chapter VII of this Report. It is, therefore, not necessary to repeat this discussion for the industrial section alone.

The recruitment and training of an experienced managerial group for the new industrial enterprises is plainly one of the most important functions and responsibilities of the Industrial Development Corporation.

In view of the crucial importance attributed to this problem in the development program, this responsibility of the IDC to provide facilities for training and education of executives is of the greatest importance and must not be underestimated. Appropriate programs should be vigorously initiated beginning now, so that the maximum possible training will have been achieved by the time new ventures are ready to go into operation.

b. The Training of Executive Officers and Managers

The selection of properly qualified candidates for training as executive officers and managers must be done with care. The qualities and abilities needed by a manager include not only technical knowledge; it is even more important that they have business acumen and the capacity to make judgements in a wide variety of matters, and that they have leadership abilities. Much depends on the personal qualities of the individual concerned. Potential managers should be selected on the basis of organizing ability, business acumen, capacity for effective human relations, sense of responsibility, integrity, enthusiasm, drive and leadership.

There is no guarantee that any amount of formal training and experience can produce a capable manager unless he possesses native talent and aptitude for such work. Having made a careful selection of individuals for management training, the actual training and experience can best be gained abroad where advanced technical training and "in service" experience in industry can be obtained. This can and should be supplemented by training in business administration and in finance.

4. TECHNICAL AND SKILLED PERSONNEL TRAINING PROGRAM

The recruitment, selection and training of these types of industrial personnel is an equally important function of the IDC. Without these men and women it will be impossible to operate the new industrial plants effectively.

a. Professional Training

The professional training of engineering and scientific personnel can be carried out by the University of Rangoon College of Engineering augmented by training students abroad until the staff and facilities of the College of Engineering have been expanded to meet the requirements.

The selection of candidates for such training can be made from those whose educational record, work experience and references indicate they have the qualities required. Their selection need not be limited to graduates in engineering, though in most cases engineering training would be an asset. The formal or university training provides only the foundation for those who are eventually to manage industrial developments. Experience in the actual field in which they are to work is more important than educational training. After completion of their formal education, candidates for managerial posts must work in plants of the type they will be called upon to manage a sufficient time to become thoroughly familiar with the problems of management. Where a new industry is to be operated under a management contract, most of that experience may be gained in the industry under the foreign managers and technicians after their return to Burma, but it is desirable to have at least two years in a well-organized plant abroad before starting practical training at home.

It is reiterated that candidates for management posts must be carefully selected on the basis of their general ability and fitness rather than on academic records. Performance in service is the ultimate test and a continuous "weeding-out" process of the inefficients and advancement of the capable is an indispensable part of the process of developing a trained management group. Here again, the academic training is only the foundation on which to build experience in supervising and controlling industrial operations and processes. The actual experience must be gained in the industry. A capacity for organizing is important and should be considered along with technical ability in selecting personnel for these supervisory positions, since the responsibility for maintaining efficiency in operations and for maintaining the quality and uniformity of the product will depend upon them. Advanced engineering degrees are not important in the training of operating personnel except for a few positions where product control or research may require such specialized training.

During the period of fabrication of the equipment for the plant, those who are to serve as supervisors and engineers should work abroad in the factory of the fabricator or in an industry of comparable type using similar equipment in order to gain experience on the construction, operation and maintenance of the machines. The experience thus gained will go a long way toward insuring efficiency in the operation of the new plant.

When the decision is reached as to the specific industries that are to be developed in the early stages of the industrial plan, the Ministry of Industry and the Ministry of Education should jointly plan the orientation of courses at the University and the number of students that should be trained to meet the needs of the industries.

b. Sub-professional Training

Many sub-professional engineers will be needed as assistant supervisors, foremen, laboratory assistants, draftsmen, etc. While less intensively and less broadly trained than University students they obtain in three years of study sufficient engineering knowledge within their specific field to do most of the operational engineering work. Because they can be trained more rapidly than graduate engineers, and because many more of them will be needed, they will be of great importance in an accelerated development program. Facilities for their training deserve very high priority.

The Government Technical Institute at Insein has been re-established to train sub-assistant engineers. The first class will be graduated in 1954. There are 154 students this year, in their first two years of work. An additional 120 can be admitted next year, but both equipment and faculty are lacking. There are at present four instructors and two lecturers. Ten additional instructors must be obtained. The Ministry of Finance has granted sanctions for salary increases too small to attract instructors. Salaries are still so low that government departments outbid the Government Technical Institute. This bottleneck is of great importance to the development program. This institution should be given preferential treatment. Sanction should be obtained at once for considerable salary increases and if local personnel are not available a responsible official should be sent to India or elsewhere with power to make final arrangements for the necessary instructors.

The Government Technical Institute is now under the Ministry of Education. The training program and the graduates of the school are of more concern to the Ministry of Industry than to any other Ministry. Consideration should be given to the transfer of this institution to the Ministry of Industry in order that more direct control of the expansion program and orientation of courses to meet the need of industry may be attained.

c. Artisan Training

Some industrial skills under existing conditions will require basic formal training. These include electricians, machinists, mechanics, and maintenance and repair men. As industries become organized and their operating forces gain experience in their work, many of the positions in this category can be filled by "in service" training and by promoting unskilled assistants or helpers who show particular aptitude in their work. The time of greatest need for skilled workers with some formal training will be during construction and the early years of operation of the industry.

The Government Artisan Training Center can provide the basic training for industrial skills. At present only one such center exists in Rangoon. It offers a two-year course to some 150 students in nine trades. These include machinists, carpenters, diesel engine mechanics, foundry men, radio technicians, fitters and welders, automobile mechanics and blacksmiths. A building, some equipment and some staff are available for a training center at Mandalay. The opening is dependent on the construction of a workshop by the Public Works Department. This should be expedited.

Teachers must be trained before other centers can be opened. Teachers can be obtained by selecting the most promising graduates of the Artisan Training Center and the Technical Institute and giving them further specialized training using the same facilities. Such a plan would save time and would economize in the use of scarce training facilities.

d. Skilled Labor

The Rehabilitation Brigade is carrying out a specialized program of training workers in construction and related works. It has expanded rapidly. It should be encouraged but needs no special help at this time. It is organized as a Board, and has been freed from the financial restrictions that are retarding the other educational programs. The demand for the trades being trained by the Rehabilitation Brigade will be considerable during the construction period of each industrial plant and will be much less after the plant is put into operation. These forces may be transferred from a project for which the construction has been completed to one on which construction is to be started. The demands from other fields including housing, irrigation, port development, mining and highway construction will draw heavily on the available supply of these trades and the need for further expansion of this training service must be emphasized.

5. CONTINUITY OF INTEGRATED PROGRAM

It must be emphasized that a large-scale development program of this type is not a static or fixed program. To make it most effective it must be kept fluid. Certainly a well planned initial program is essential in order to insure the orderly development of the resources of the Union in the most effective way.

Resources that are not now considered to be suitable for conversion into useful products may become suitable due to the development of some new process. New raw materials such as iron ore may be discovered. Known sources of raw materials located in inaccessible regions may become available due to the establishment of new transportation facilities. The funds available for the construction of new manufacturing facilities may accumulate more rapidly than has been anticipated, or more slowly, allowing or requiring adjustments in the basic plan. To obtain the maximum results from a development program it must be constantly revised to keep it abreast of changing conditions. To do this requires constant and intelligent supervision. This can best be provided by maintaining a small planning and economic group attached to the Industrial Development Corporation.

CHAPTER XXIII

THE DEVELOPMENT OF SMALL-SCALE INDUSTRY

A. IMPORTANCE OF SMALL-SCALE INDUSTRY IN THE BURMESE ECONOMY

By far the largest part of the manufacturing and processing activity of Burma is carried on in small local enterprises using simple methods of production. Under any plan of development, their importance will continue for a long time to come. There is a need, therefore, for considering the role, nature and problems of these activities and to make appropriate recommendations.

Generally, in the discussion which follows, the data and comments apply to all types of small manufacturing and processing units. These may be taken to include both "cottage industry"—work carried on wholly or primarily by members of a family; and "small-scale manufacturing"—establishments operated mainly with hired labor, employing up to 50 workers when power is not used and 20 when it is. The more general term, small-scale industry, will be used to apply to both.

1. PRESENT EMPLOYMENT AND PRODUCTION

Until the present census is completed, there will be no reliable country-wide data on this sector of the economy. Very rough estimates of the present number of workers in small-scale industry by major types are presented in Table XXIII-1. These were derived, by a series of assumptions, from 1931 census data on industrial occupations, and must be interpreted as only the most approximate of indicators.

The indicated total of 800,000 workers presumably includes some but not all working dependents and workers who had a principal employment other than in small-scale industry. The actual total including all such workers is probably in the neighborhood of one million. This suggests that approximately 75% of all industrial workers and perhaps 12% of the total working population are engaged in small-scale manufacturing or processing for at least part of the year.

The typically small number of days worked per man per year and the low productivity of labor in small-scale industry to some extent also characterize the large agricultural and trade sectors. Likewise, the aggravation of these factors by the present depressed state of activity is widespread. Nevertheless, there are indications that annual production per worker in small-scale industry is somewhat below the national average for all economic activity. This means that the proportion of total national output and income which is produced by small-scale industry is less than 12%, i.e., less than the proportion of total workers who participate in small-scale industry. It is probably in the neighborhood of 10%.

TABLE XXIII – 1

ESTIMATE OF NUMBER OF WORKERS IN SMALL-SCALE INDUSTRY

(Excluding some working dependents and some workers with principal occupation elsewhere)

	Estimated Number of Workers	*Per cent of Total*
Cotton spinning, sizing and weaving	304,000	38
Rice processing; sugar, toddy and other food industries	88,000	11
Work with lacquer and bamboo, cane, and other woody materials	80,000	10
Tailoring, shoemaking and other industries of dress	80,000	10
Silk spinning and weaving	56,000	7
Carpentry and furniture making	40,000	5
Wood cutting and charcoal burning	32,000	4
Jewelry and ornament making	24,000	3
Tobacco manufacture	24,000	3
Metal working—blacksmiths, etc.	24,000	3
Ceramics	24,000	3
Timber sawing	8,000	1
Building industries	8,000	1
Match, oil, soap, paper, and other chemical product industries	8,000	1
Total	800,000	100

A type of economic organization which is employed in the production of a broad variety of goods, which is widely dispersed geographically, which provides some employment to more than one out of eight workers, and which produces about 10% of the nation's output and income is obviously an integral and important part of the present economy.

2. PROSPECTIVE FUTURE ROLE OF SMALL-SCALE INDUSTRY

The ability to supply limited local markets with perishable or bulky commodities, to produce individualized artistic products, to employ part-time labor, and other special characteristics make small-scale production the most suitable form of enterprise in certain areas of production. It is sometimes assumed that wherever large-scale factory production can turn out more product per man-hour than small-scale industry, after allowance for the cost of operating the machinery, factory production is economically and socially advantageous to small-scale production. This conclusion is not tenable. There are many persons eager for work who can accept it in their villages, in many cases for only part of the year, and whose lives will benefit by the work, but whose family circumstances are such that they cannot be drawn to a factory, even at wages two or three times their earnings in small-scale industry in or near their homes. In other cases, the workers can be drawn to factories, but the social costs of the disruption of community life are great. In these circumstances, small-scale industry provides employment which is socially and economically advantageous to the country.

Still, a much larger part of total industrial output than is now the case could advantageously be produced by large centralized enterprises. However, whatever the direction or extent of economic development in Burma, common sense and historical experience elsewhere indicate that introduction of such large-scale production as is economically and socially advantageous takes considerable time and is never fully realized. Movement in this direction is a gradual process. The elements of such a change—technological re-organization not only in industrial production but also in transport, trade, and other sectors of the economy which have to be suitably expanded and modified, capital accumulation, and concentration, mobility and re-orientation in aptitudes of the labor force—are long-run evolutionary processes. They can be speeded along by such plans and proposals as are incorporated in this Report, but the development program cannot rapidly transform the economy into one of large-scale plants, intensive mechanization, high-level productivity and resulting high-income jobs.

Small-scale industry will continue to furnish to many workers higher income employment than any alternative available to them. It will be a source of output to meet local needs which could not otherwise be fulfilled. This will be true for a great many years, though in gradually lessening degree. Its importance will begin to decrease relatively to other sectors of the economy only as the number and diversity of sizable manufacturing plants substantially increase in Burma. Actually, small-scale industry has certain features which will make its expansion desirable for some years to come.

3. SPECIAL IMPORTANCE AS SOURCE OF EMPLOYMENT FOR SEASONAL LABOR

Additional importance attaches to this form of economic enterprise because, in view of its limited requirements for capital, organization and highly trained labor, it can, to a very large extent, be operated intermittently. It therefore can, and does, provide supplementary employment to some part of the large seasonal labor force which would otherwise be idle for a large part of the year.

Seasonal unemployment in Burma is attributable mainly to the agricultural cycle. Of the agricultural labor force, an estimated five million workers are potentially free of cultivating duties for part of the year. Not all are available for employment in small-scale industry. Some are firmly content with or insist upon remaining idle. Some, especially in inaccessible backwoods areas, are not otherwise employable because of geographic and occupational immobility. A few find complementary seasonal work in large-scale industry. (A prewar study indicated that employment in the largest industrial outlet, rice-milling, whose peak and trough roughly complement those of agriculture, varied over the year by only some 30,000 workers. The seasonal variation for the larger enterprises in rice, cotton and saw milling, petroleum extraction and refining, mining and in public administration, combined, was of about the same magnitude.) A relatively large number of cultivators and hired farm workers could be absorbed in seasonal public works projects, such as roads, bridges and buildings. Brief and intermittent employment is and will continue to be found in collection of various kinds of forest produce, carting, boating and miscellaneous casual labor, as on the docks. A good many engage in petty trading or do odds and ends of other useful work intermittently, but very few of these can be properly considered as effectively employed. Extension of double-cropping by means of irrigation will reduce the available number of seasonal agriculture workers. However, making maximum allowance for all these factors, including future expansion of manpower needs, it is estimated that a pool of up to two million workers remains, which cannot be employed during the off-season in any reasonably productive manner other than in small-scale industry.

This two-million figure represents only agricultural workers free in the off-season; it does not include other types of seasonally unemployed workers or those who, for whatever reasons, are obliged to seek their main means of livelihood in small-scale industry. It is abundantly clear, therefore, that compared to the estimated one million workers of all kinds who now participate in this sector of the economy, the number who could and would be willing to be so employed and who have no alternative job opportunities in prospect, at least for a large part of the year, is far larger. This suggests the desirability of rapid expansion of small-scale industry in the Burmese economy in the immediate future.

B. POLICIES FOR DEVELOPMENT OF SMALL-SCALE INDUSTRY

The problems which must be overcome to improve and expand small-scale industrial enterprises largely overlap and can be considered together. Because this sector of the economy is made up of small, isolated production units, using diverse raw materials and techniques and often operated intermittently, it is a natural "problem area." Under existing economic conditions, it faces "critical" problems running the gamut from procurement of raw materials to disposition of end product. This has often led to the proliferation of exhaustive and complex schemes for thoroughgoing reconstruction of small-scale industry. However, the same conditions that create these problems render their solution especially difficult and elusive. To attack them all individually would exhaust the administrative talent and energy at the disposal of the Government, and would yield exceedingly small returns for efforts put forth. Indeed, the economic cost would probably be greater than the gain. The most feasible approach is to focus attention on fostering certain key developments which will act as catalysts for further improvement. In broad terms, these consist of extending the market for products of small-scale industry, stimulating cooperative organization for self-help purposes, providing adequate credit facilities, and providing cheap electricity for power. In addition, certain direct steps to improve productive methods can be helpful. Specific policies for effecting these developments are discussed below.

1. EXTENSION OF THE MARKET

The greatest single inducement for expansion and improvement of Burmese small-scale industry is to be found in an increased demand for its products. The degree of expansibility—in the form of unused resources, native ingenuity, spirit of enterprise, and the knowledge or the ability to acquire independently knowledge of better methods—which now exists on the production side is sufficient to meet a very large increase in demand without specific aid from the Government. Small-scale industry is operated by individual enterprises. Their best abilities are induced when there is a market for their goods.

By far the greatest opportunity is offered by the home market. Conventional products of small-scale industry cannot generally compete in price or quality in foreign markets. The foreign market for specialty items is small, demanding, and unstable, and only a few Burmese products would be suitable. Any major effort in the direction of exploiting foreign markets would produce disproportionately small returns.

The stimulation of domestic demand in general through enlarging purchasing power and the money supply is desirable on many grounds. It requires broad policies discussed elsewhere. The demand for products of small-scale industry will increase in full measure with such an increase of income and demand in general.

Some of the current demand and more of the potential demand for products of small-scale industry in Burma cannot be exploited because of inadequate internal transportation and communication facilities and sales services. Local resources, traditions, and other factors make for considerable specialization within Burma both in products and qualities. However, trade between the regions of the country is frustrated by the inaccessibility of distant markets and absence of convenient sales outlets. Many distinctive and seemingly marketable items produced elsewhere in Burma are not even available in the large Rangoon market. As a result production is largely orientated to restricted local demand; often to traditional customers plus occasional special orders.

The long range benefits which would accrue to small-scale industry from the development of a cheap efficient network of road, rail and river transport and of rapid communication are incalculable. The extent of the network must not be limited by the requirement that it be self-supporting immediately. The expansion of activity which will eventually increase transport and communications revenues must await the prior provision of these services themselves. The stimulus to small-scale industry and to all other sectors of the economy as well, and the political and social effects of binding the Union together, justify investment and current operating costs in these fields far beyond those justified by immediate direct financial returns. A broad program for the needed development of transport and communication facilities is outlined in Parts IV and V of this Report.

The organization of sales services in Burma is primitive. Competition and local knowledge insure that the profit margin exacted by the marketer of products produced within a small community for the local market is held to a minimum. But such non-local trade as exists in the products of small-scale industry follows inflexible, traditional channels, and is typically in the hands of monopolists, many of whom exact very heavy margins. The principle of high unit margins rather than high volume is advantageous to the individual monopolist. The resulting high prices discourage sales, while the low returns to producers minimize incentives to production.

The need for government action in this field has long been recognized. Even in prewar days, aid in marketing as well as in procurement of raw materials and equipment was provided to the important weaving industry through a "Burma Handloom Textile Depot," which had a working capital of K40,000. In 1948 this was reconstituted as the "Central Procurement and Marketing Depot" with the aim of providing such aid to all small-scale industries. However, it has only the barest minimum of staff and facilities and only K20,000 available as working capital. Consequently, its activities have been limited to advice on supply sources and prices and occasional procurement of a small amount of critically needed materials and equipment, primarily for a few cooperatives and industrial associations. Marketing operations are virtually non-existent.

Even in its original conception, the depot does not begin to meet needs. The marketing function, by itself, warrants treatment as a major project. This would take the form of bulk purchase of small-scale industry products from organizations of producers, preferably cooperatives, and the display and large-scale sale of such products, both wholesale and retail.

To provide the necessary autonomy and flexibility for commercial operations, such a project should be conducted outside of the framework of conventional governmental administrative and budgetary procedures. Precedent is found in the various Government trading boards, the Civil Supplies Board offering the nearest parallel. Which Government department would exercise nominal control is a matter of administrative expediency. At the outset, it would seem advisable to continue to place responsibility for marketing of small-scale industry products with some branch of the Ministry of Industry. In any case, the governing board should consist of representatives of all interested agencies, including the appropriate branches of the Ministries of Industry, Commerce, and Cooperation and Commodity Distribution.

As a first step, such a board should be constituted to make a brief study of the problem (including perhaps an investigation of the operation of the large Government retail store in Bangkok), and then to organize and place into operation a large emporium in Rangoon. Both the desirability of immediate action and need to gain experience dictate that the original enterprise should not be too ambitiously planned—in terms of buildings, facilities, and even scale of operations. For example, it should not initially match the establishment at Bangkok. However, the scale should be that of a large commercial enterprise to give the project an adequate trial and to provide realistic experience in such operations.

If an increasing volume of sales is successfully promoted by making the products readily and cheaply available, and without Government subsidy of costs after full operation is reached, the program should be gradually expanded to cover other large population centers. The extent of Government activity in this area should be determined by the achievement of the results desired. A relatively small participation may be sufficient to "pitch" the market to reasonable and stable price levels and to prod private trade into more efficient practices. As cooperative organization matures, it will be desirable to transfer such activity to a federation of producer cooperatives. Experience elsewhere indicates that effective cooperative production requires organization in the marketing field as well. In the meantime, governmental activity in this field will promote the further development of cooperatives which is necessary before they can take over.

Such a project would contribute indirectly but effectively to the solution of other problems for which direct measures are not presently feasible. Large orders and regular marketing would foster stability in prices and output, and promote uniform quality and standard weights and measures. Unreasonable middlemen profits would be reduced, including the large interest element for carrying stocks until they are sold. The marketing agency would also be in an excellent position to help in channeling cheap Government credit to small-scale industry. The resulting greater returns to producers would stimulate production and both encourage and enable them to introduce new techniques and to acquire capital equipment, even on their own account.

2. DEVELOPMENT OF COOPERATIVES

The tiny size of small-scale enterprises tends to render them permanently "backward" unless they are integrated in some way. Governmental aid cannot be effectively applied at each point of operation, and individual resources and know-how are ultimately inadequate for independent progress. The most hopeful path for realizing most of the reforms needed is association of enterprises with similar interests along cooperative lines. These associations can serve as agencies for bulk purchase and marketing, financing, standardization, and introduction of new techniques. They can initiate such activities spontaneously and also serve as channels through which Government action is funneled and organized. A by-product would be the greater ease with which Government could obtain data for ascertaining needs and for checking on progress.

The problems involved in cooperation are numerous and complex: education in cooperative techniques, active member participation, training of officers, internal financing, administration by a properly staffed organization for the larger cooperatives. Cooperative growth must proceed gradually, apace with the solution of these problems. However, "growing pains" are inevitable, and minor errors and difficulties should not deter vigorous promotion of this basic organizational change needed in small-scale industry.

3. PROVISION OF CHEAP AND READILY AVAILABLE CREDIT

Very few individual small-scale enterprises have enough capital to finance ordinary operating costs, much less expansion and improvement of capital equipment. In the absence of other sources of credit, chief reliance is placed on "loan sharks," particularly middlemen who provide raw materials on credit and, often as a condition for such credit, obtain the finished products. Their monopoly position enables them to levy exorbitant charges and to keep small operators in a state of virtual peonage. At the lacquer center of Pagan, for example, loans are made at the rate of 3% per month, and are restricted by the requirement of gold collateral (jewelry with a gold content of twice the value of the loan).

Loans from commercial banks or other private agencies at reasonable rates are inaccessible. Independent financing by cooperatives on any sizable scale is a long way off. Government credit to date has been inadequate in amount and has involved complex procedures. In the case of loans to weavers, for example, 27 field supervisors investigate applications and make recommendations to the Cottage Industry office, which, after processing and checking, forwards them to the district commissioners. At this level, final action is taken by a special committee headed by the district commissioner. The supervisors are responsible for collecting loans.

Under these conditions, the provision of cheap credit by Government represents a basic need which can be met immediately and with relative ease. Methods of channeling this credit to small-scale industries are discussed in detail in Chapter IV. Overall credit policy should continue to be formulated at the top levels of administration generally responsible for fostering small-scale industry. But individual loan transactions should be made on the spot by a special financial organization. The proposed credit organization would constitute a component branch of the Directorate of Industries re-organized as suggested in Section C of this chapter. It would open up loan offices only in areas where there will be a sufficient volume of credit demand to keep the administrative costs of loans low. These would be mainly in the larger urban areas. In other areas funds can be provided by the credit organization through the district branches of the State Agricultural Bank or the Directorate of State Agricultural Credit.

4. PROVISION OF POWER AND EQUIPMENT

The provision of a cheap means of mechanical power is probably the most useful single contribution which can be made toward creating an environment favorable for continuing improvement in methods of production in small-scale industry. This has been a major element in industrial revolution elsewhere and its potential effectiveness in Burma is foreshadowed by the eagerness and success with which mechanical power has been used when available.

Burma is fortunate in possessing the water and coal needed to develop rapidly a national grid for serving the entire country with inexpensive electrical power. In addition to providing the indispensable basis for technological advancement in industrial production, which in Burma for some time to come signifies small-scale industrial production, the broader advantages of such a development—cultural, social and political, as well as economic—would be vast in scope. It follows, therefore, as in the case of transport, that cheap power need not be required to pay for itself immediately. The stimulus which new power projects would provide for small-scale industry alone should not be viewed as an incidental by-product, but as a prime rationale for their introduction. An appropriate power program for Burma is described in Part VI of this Report.

In cases where power equipment of certain types is unfamiliar, it will be desirable that Government supply pilot models. When the necessary organization can be created, standard items capable of widespread use such as sewing machines, power looms, wood and metal-working machines (and certain kinds of non-power tools and apparatus as well) could then be supplied on a large scale under easy credit terms. Such aids would serve to accelerate the rapid technological transformation which would follow upon the provision of a cheap means of power.

5. DIRECT AID IN IMPROVING METHODS OF PRODUCTION

Methods of production in Burmese small-scale industry are primitive and inefficient. In the important handloom-weaving industry, for example, it is estimated that only about one fourth of the looms are equipped with the flyshuttle. In this and other cases, very small and simple improvements would produce quite remarkable results. However, small-scale industry consists of scores of different occupations and of many thousands of establishments scattered in villages throughout the country. The largest single industry or group of industries—cotton spinning, sizing and weaving—includes only about one twentieth as many workers as agriculture, but is scattered almost as widely throughout the country. The institution of such reforms in small-scale industry—by means of research, extension services, training centers, pilot plants and other devices—is therefore an extremely difficult and long range task. It is tempting to recommend an elaborate research service to learn of and test simple improvements and a corresponding extension service to carry demonstrations of them to small-scale establishments throughout the country; but it is believed that the problem of obtaining technicians who could do it effectively and of setting up and operating the necessary administrative machinery are such that the project would draw heavily on the scarce administrative resources of the Government and would not bring returns commensurate with its cost. The resources of the Government will be most effectively utilized if they are concentrated on promoting selected improvements which can most readily be introduced into widespread practice.

A United Nations Technical Assistance program intended to accomplish this purpose has been established. A team of 11 foreign technical assistants and several Burmese experts from the Cottage Industries office have instituted a program of technical aid to small-scale industry. Concrete plans have been made and in some cases implementation is under way for introducing improvements in the textile printing, power-loom weaving, sericulture, silk reeling, silk weaving and dyeing, pottery, handmade paper, sugar refining, and condensed milk industries. Two additional technical assistants will arrive soon to extend the program to the woodworking and electroplating and anodizing industries. The forms of aid vary and include the establishment of training centers, which in some cases will be built around complete pilot plants; establishment of research and development facilities; and on-the-job advice to existing enterprises. Primarily, the orientation is the introduction of new or improved production techniques and improvement in quality, design and pattern of the products. In some cases, attention is also devoted to marketing and industrial organization, especially cooperative organization. The significance of this program is enhanced by the fact that it is orientated to the immediate practical needs of the industries and to persons working or about to be working in them. For example, some 15 printers who have attended textile printing classes already have introduced the new screen-printing process in their establishments, and it is planned that sericulture trainees will be used for instruction and other work in implementing the three-year program for self-sufficiency in silk production.

Such aid can be made more effective if, having demonstrated the advantage of simple improvements in methods, the Government arranges to provide on credit the kit of tools or set of equipment needed to put them into practice. This has been suggested above in relation to the introduction of power; there is no reason why it should be limited to the introduction of power tools. Such a program is however subject to abuse and waste; handling it is one of the processes which requires the detachment from other duties of an administrator of ability. Without proper administration the program could be costly and ineffective. It is believed that this selective aid can be of great value. To attempt to elaborate it into a full-scale extension system for all small-scale industry is however not recommended.

C. IMPLEMENTATION OF POLICIES FOR DEVELOPMENT OF SMALL-SCALE INDUSTRY

Responsibility for governmental encouragement and control of small-scale industry is mainly in the hands of the Directorate of Industries, within the Ministry of Industry. The growth of cooperatives tends to increase the role played by the Cooperative Societies Department of the Ministry of Cooperation and Commodity Distribution. The coordination of the activities of these two agencies towards the end of fostering common goals will require increasingly closer liaison. The establishment of a permanent joint committee to insure mutually consistent plans and, as far as possible, mutually exclusive fields of operation would serve a useful purpose.

Within the Directorate of Industries, work in connection with small-scale industry is presently carried on directly by the Directorate itself and by two sub-agencies—The Directorate of State Aid to Industries and the Office of the Superintendent of Cottage Industries with its several sub-departments. The allocation of duties reflects the gradual accumulation of new functions and their superposition on the previous structure. The result is that responsibilities and powers are not clearly defined and that some activities are duplicated while others are inadequately provided for. The system of loan administration discussed earlier is a case in point. The observations in Chapter VI concerning the need for internal restructuring of governmental agencies are fully applicable here and a reorganization of this important department is recommended.

The Directorate of Industries is responsible for industrial development as a whole including large-

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scale industry. However, for a long time to come, the latter will consist of relatively few enterprises, whose actual operation in any case will be under the aegis of the Industrial Development Corporation. Other Burmese industry can be treated together for purposes of governmental aid and administration. This suggests that sections of the Directorate of Industries should be organized along functional lines, each responsible for a specific major program such as planning, research, credit, technical aid and procurement of supplies and equipment, training, inspection, marketing, and collection of information. Existing staff could be concentrated in a section concerned with the highest priority programs; other sections would be built up over time. With each such section reporting directly to the Director, integration and implementation of plans for industry as a whole would be promoted. Functional specialization would have the particular advantage of rationalizing the use of Directorate personnel, an important factor in view of the chronic shortage of staff. The necessity now of combining divergent duties in one man or section could be partially reduced by eliminating duplication of certain activities among sections.

The planning and implementation units recommended for each major governmental agency in Chapter VI will have very important roles to play in the Directorate of Industries. Effective work by these units will require much more information than is now available concerning the small-scale industry sector of the economy. Comprehensive statistical data for this sector are particularly difficult to collect and interpret. However, selective surveys and field studies can be very useful when existing information is so scarce. Consequently, a special section within the Directorate of Industries should be adequately staffed so that it can undertake collections of statistical and other information of the highest priority.

The personnel problem requires immediate and direct attack. The present staff can hardly keep up with existing routine activities, much less expand its program, engage in long range planning and exploratory work, and collect necessary data. The policies for development of small-scale industry suggested in this chapter were based to a great extent on the fact that only limited administrative resources would be available for a long time to come. However, additional activities of any kind could not be successfully sponsored with present staff, nor with the addition of only a few more persons. Special training is unavailable for administrators in this field. The only course is to recruit a growing number of energetic persons of good intelligence and an interest in this type of work who will acquire experience on the job. These large, general personnel requirements cannot be met with foreign technicians. However, the latter can be of great value in helping to set up programs and train staff. Industry specialists also can help to meet some of the specific needs of individual industries, such as introduction of new techniques.

D. SUMMARY OF RECOMMENDATIONS

1. Improvement of transportation and communication and development of cheap electric power should be accelerated for their effect on small-scale industry as well as on the economy generally.

2. A test should be made by the Government of the effect on the market for products of small-scale industry of quantity purchase and marketing. If successful in stimulating sales of products from other sections of the country in the Rangoon market, this procedure should be expanded.

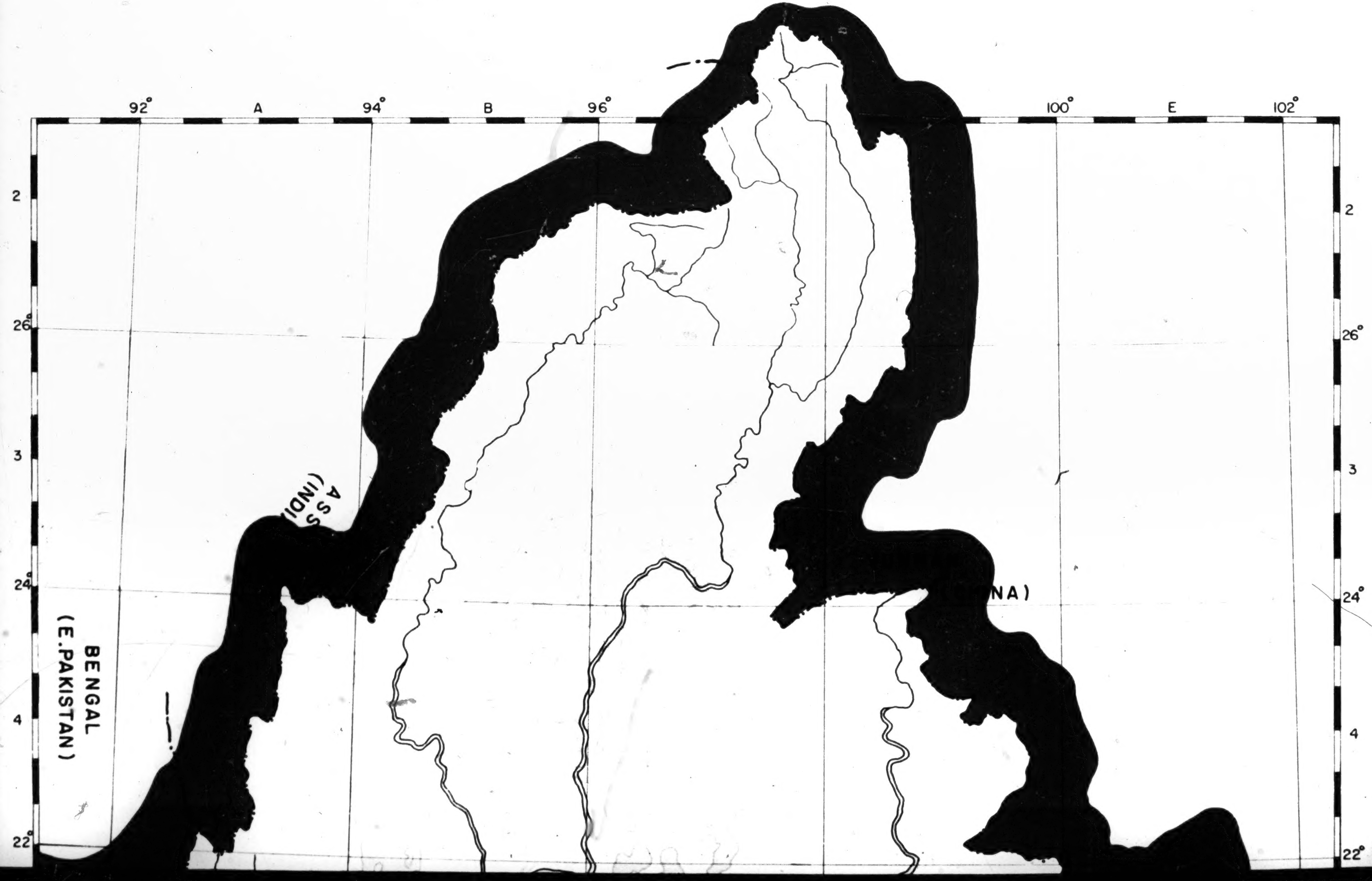
3. The Government should encourage the orderly growth of cooperatives as agencies for bulk purchase and marketing, financing, standardization, and introduction of new production techniques in respect to small-scale industries.

4. The Government should establish an expanded system for directly providing cheap credit for small-scale industries.

5. The Government should assist in making electrically-driven and other tools and equipment available to small-scale enterprises.

6. Present technical assistance programs for improving production methods of Burmese small-scale industry should be continued.

7. The Ministry of Industry and Ministry of Cooperation should, perhaps by creation of a joint committee, establish a closer liaison in respect to small-scale industry matters. Reorganization along functional lines of the sections of the Directorate of Industries dealing with small-scale industry and clarification of lines of authority is also desirable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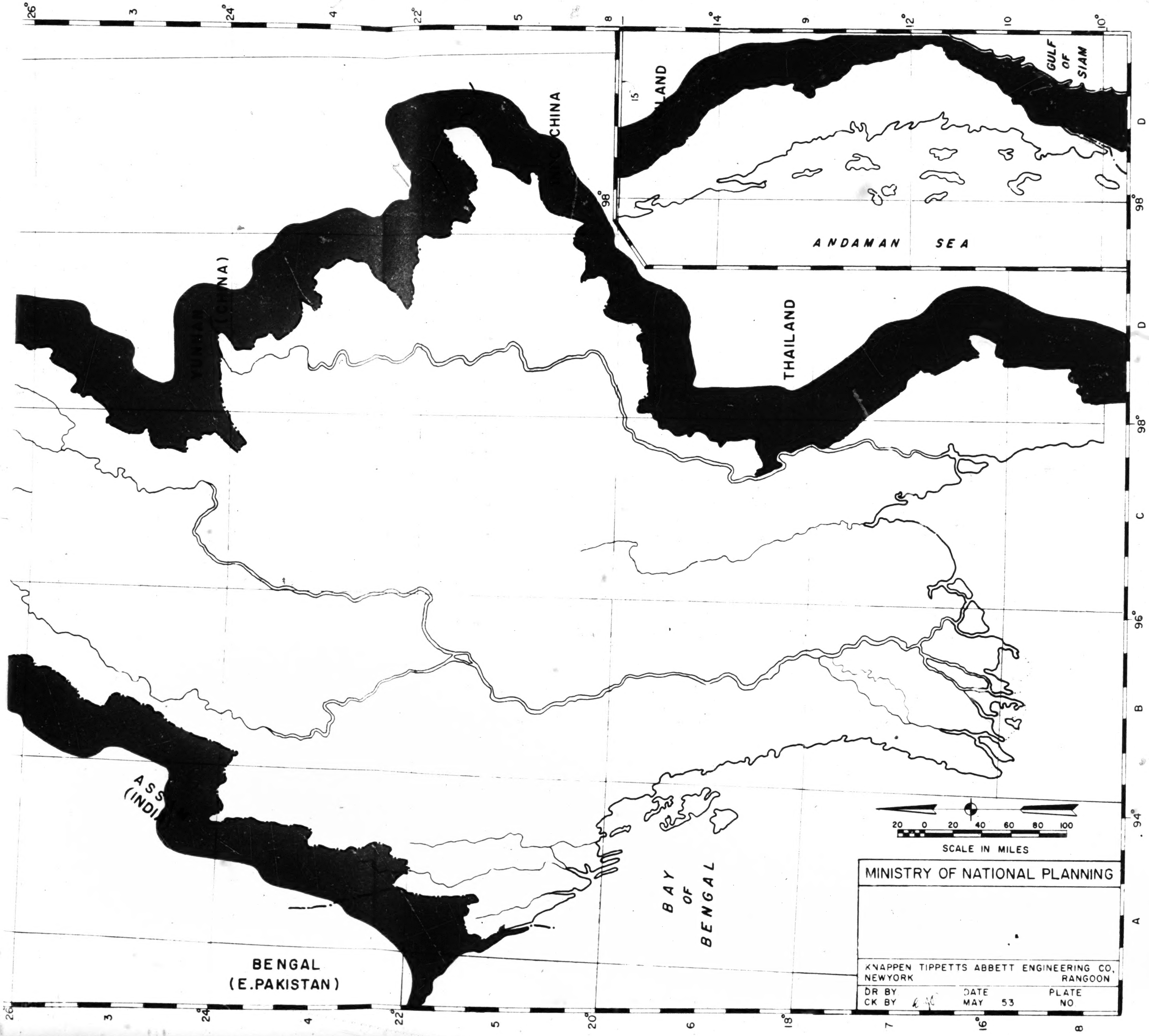
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CHAPTER XXIV

FORESTRY AND OTHER INDUSTRIES

A. FORESTRY

The forests of Burma comprise one of her greatest assets, and the exploitation of forest products one of Burma's potentially most useful industries. The status and composition of the forests, the present arrangements for forest management, and data on present consumption of forest products were given in the Preliminary Report. Projects for the further exploitation of a few specific forest products are discussed in Chapter XXII of this Report. Additional information is presented here regarding extraction, milling, and commercial utilization of both teak and other woods. The forest reserves of Burma are shown on Plate 1.

1. CONSUMPTION

a. Teak

For teak, available information indicates that the sustained extraction is approximately 400,000 cubic tons of round logs a year. The total will exceed this because all dead and windblown trees will be taken out as encountered. During the war years no normal extraction operations were carried on. The only teak extraction was performed by the occupying forces for military needs. Because of the limited extraction in recent years it would be theoretically admissible to exceed the normal sustained-yield figure for a period of ten years during which up to 500,000 cubic tons could be withdrawn without any harmful effects on the forest reserves.

Practical considerations however set effective limits on teak extraction. Security conditions constitute such a limitation. Equally important, perhaps, is the limitation set, under present methods of extraction and transport, by the number of trees girdled.

A girdled teak tree must be left standing at least three years before being felled and extracted, and extraction and transport to mill take another three years. The backlog of girdled standing trees should therefore be in the neighborhood of two and a half million cubic tons of round logs to support a sustained yearly flow to sawmills of 400,000 cubic tons. The present backlog of girdled trees does not exceed 1·2 million cubic tons.

Extractions for the year 1952–53 are estimated at about 80,000 cubic tons and new girdlings at 60,000 tons, so that even at the present reduced rate of operations the backlog of girdled trees is decreasing instead of rising. Unless methods of transporting logs shift from flotation to barge, rail, or truck—and it is by no means clear whether such a shift is feasible and economic—a marked and immediate step-up in the amount of trees girdled is vital not only to the achievement of output targets in the teak industry, but even toward the sustaining of current output levels. Under present security conditions this can probably be accomplished best by a reallocation of security forces as between girdling and extraction in order to restore balance between them. For the time being, this would favor girdling. As security conditions improve, the emphasis on girdling should be maintained until the backlog of "fellable" trees reaches a point where it can continuously support the extraction level contemplated.

b. Non-teak Hardwoods

With respect to non-teak hardwoods, studies made in the last three years have indicated that the utilization and extraction of such hardwoods can be greatly expanded. It has been estimated that 130,000 cubic tons of durable, 560,000 cubic tons of semi-durable, and 50,000 cubic tons of non-durable hardwoods could be used for the year 1952–53. For the year 1959–60, approximately 190,000 cubic tons of durables, 640,000 cubic tons of semi-durables, and 60,000 cubic tons of non-durables could be consumed.

2. EXTRACTION

a. Elephants

For the past 100 years, Burma has been working her forests almost wholly with animal power, particularly trained elephants. In 1941 it was estimated that approximately 5,000 well-trained elephants were used in the extraction of timber. There are now about 3,000.

To have sufficient power to meet the indicated demand for round logs will require immediate steps to develop additional power sources. One possibility would be an intensive program for training work elephants. However, it is questionable whether enough elephants could be trained to support the planned expansion. For this reason it now seems advisable to supplement extraction process by additional mechanical equipment.

b. Personnel

At the time of the nationalization of the timber industry, there were approximately 4,800 persons engaged in extraction. These were all specialized, experienced and trained personnel. There are at present about 4,000 persons in the extraction department of the State Timber Board. It is estimated that there are available in Burma about 600 trained extraction specialists available to the Board. The Board considers that this number would be sufficient to produce the required amount of round logs. When a training and experimental program of mechanical extraction is established, it will be necessary to train men in new techniques of extraction.

c. Mechanization

There are many features of mechanization that can contribute greatly in acquiring a more efficient and expanded extraction. Increased mechanization of extraction will require more roads that will withstand the monsoons and the rough treatment from mechanical equipment. Such roads will be needed not only to transport logs but also to bring in fuel, supplies and parts. Expansion of Burma's general network of roads must also be closely coordinated with the exploitation of forest reserves.

Dr. Ing. K. A. Miedler, FAO forestry officer, has made recommendations which include a list of equipment for a proposed experimental and training extraction unit. This list proposes: tractor yarding equipment, loading equipment, trucks, special equipment, power saws, babbitting tools, and spare parts. The total estimated cost of this equipment is between $165,000 and $200,000. The State Timber Board Extraction Department has at present 15 pieces of old army surplus equipment comprising D–4, R–4, and D–8 tractors in use at two forest reservations. This equipment is in very poor mechanical condition with practically no spare parts available. Operations are therefore much handicapped by breakdowns and delays.

There are no data or figures available that would give a realistic or reliable cost of mechanical extraction in Burma. It is believed that mechanical extraction can in many areas be substituted for animal power with resulting savings. It is therefore urgent that a definite program be implemented for studying the possibility of expansion. Along with mechanization, consideration must be given to roadways that will be needed. The major considerations here must be the degree of permanency of the roads and the gross weights they will be required to carry (see also Chapter XIV).

d. Reserves

The annual extraction of 400,000 cubic tons of round logs of teak would require working approximately 160,000 acres of reserved forest areas. A larger market for semi-durables, non-durables, and others will make it advisable to extract these woods when extracting teak, thus permitting a larger volume of total extraction from each area. With due allowances, this would mean working approximately 200,000 acres or roughly 320 square miles.

e. Roads

It is almost impossible to estimate the mileage of roadways that may be required. By the expanded use of mechanical extraction it would be advantageous to do as much logging in the dry season as possible, requiring less wet weather roads to be built. The cost of the necessary roads for logging would have to be considered in the costs of mechanical extraction. It is estimated that the average cost of a mile of suitable roadway to withstand at least one wet season would be approximately K14,000.

f. Railways

In some reservation areas the use of a light railway line might be advantageous in that such a line can be operated during wet weather. This line could be built from used rails and materials. Such a light railway line could be constructed in extraction areas for the period of maximum extraction, then re-laid in other areas for working these until completion. In this manner, such railway materials can be used to the greatest advantage in conjunction with proper extraction cycles. It is estimated that by using 50-pound used rails and fittings, priced at 50% of the cost of new materials, a mile of such railway could be laid for about K70,600.

To these costs should be added the cost of suitable railway carriages to transport the logs as well as motive power to move them. About ten carriages priced at K30,000 each or a total of K3,00,000 would be required to transport the logs. The motive power for drawing these carriages is estimated to cost K1,00,000. If such a railway is to be used, these costs, like that of roadways, should be added to other costs of mechanization and charged against extraction.

g. Transport to Mill

The most important requisite for an economical and fully utilized timber processing operation is a continuous flow and adequate supply of logs from forests to sawmills. This supply must be uninterrupted and carried on in the most expeditious and economical manner. The location of the logs in the forests is quite distant from plants that process the logs into merchantable lumber. In many cases it is not practical to transport from forests to sawmills by railroad due to the inaccessibility of the forests. The most advantageous method of transportation for Burma may continue to be, as in the past, log raft flotation.

h. Stream Utilization

Agriculture and irrigation projects may affect future extraction and logging operations through the construction of storage dams. The economy of Burma as a whole must be taken into consideration when these stream uses are planned. Proposed dams are located on the following rivers: Mu (north of the existing diversion dam), Thitson, Sinthe, Yezin, Paunglaung, Nagalaik, and junction of Swe and Saing. The dams located on the Thitson and Yezin Rivers do not affect the logging facilities in any way.

The other dams would naturally affect the logging, and sluices should be constructed at the dams to facilitate the floating of logs. At some dams it may be necessary to have mechanical means of handling logs over the dam to permit log flotation.

3. POTENTIAL DEVELOPMENTS

a. Timber Treatment

An important factor affecting the supply of merchantable lumber is the extent to which non-durable and semi-durable woods are treated. In the light of findings of one of the largest chemical manufacturers of the United States, a company which has specialized in chemical treatment of woods, it is recommended that the semi-durable and non-durable woods of Burma be chemically treated so that a better utilization of these species can be achieved.

(1) Penta-WR, or its equivalent, is recommended for:

(a) Protection of wood against attack by decay, mold, mildew, termites and lyctus beetles.

(b) Effective control over dimensional changes such as swelling, warping, shrinking and grain raising, resulting from changes in moisture content of wood. This chemical can be obtained in concentrated form and made into ready-to-use solution by adding three or five parts by volume of naphtha, mineral spirits, or similar petroleum solvents.

The treatment of the wood can be performed by immersion in vats or tanks for a minimum of three minutes depending on the use that is going to be made of the wood. For lumber to be used under severe conditions of exposure, as in steps, porch floors, or wood continually exposed to the weather, a considerably longer soaking period and heavier absorption is recommended. Sills, joists and structural timber should be soaked in the solution until substantially all of the sapwood is penetrated.

The amount of solution for treatment of the woods will naturally vary in accordance with the sizes of the lumber and the amount of absorption required. It should be noted that gallons as herein referred to are on the basis of United States gallons. The dosage can vary between an estimated four gallons and ten gallons per cubic ton of converted lumber. From the prevailing costs of this chemical in the United States it is estimated the solution, mixed ready to use in Burma, would cost approximately 23 cents or K1.09 per gallon. This preservative material might therefore cost an average of perhaps 7 × K1.09 or K7.65 per cubic ton of lumber.

The prevailing cost f.o.b. Rangoon of average local merchantable teak is K500–800 per cubic ton; for average durables it is K475 per cubic ton; for semi-durables, K400 per cubic ton; and for non-durables K200 per cubic ton. From these figures the desirability of treatment of these other less merchantable woods can readily be seen.

(2) Penta preservative or its equivalent is recommended for:

(a) Protection of wood in soil contact or above ground in open exposure.

(b) Effective protection for wood poles and posts of all kinds and other totally exposed uses. Like the Penta-WR, this preservative can be purchased in concentrated form and diluted with up to ten parts by volume of a readily available solvent.

The treatment of woods with this preservative can be performed by dipping or in pressure vessels depending on the penetration and absorption of preservative required. The amount of solution that will be required will vary. It is estimated that the dosage will vary between 7 gallons and 17 gallons per cubic ton of timber. The prevailing costs of this material delivered in Burma, mixed ready to use, will be about 19 cents or K0·9 per gallon. The material would cost an average of perhaps 12 × K0·9, or K10·8 per gallon.

b. Standardization

Standardization of dimensional lumber would be a great stride forward in the lumber and construction industries and would expand effective markets. When standard dimensions are established all lumber can be produced to these measurements and stocked to be used as needed. Labor would be saved in wood framing by having nominal-sized pieces from all mills uniform. Floor joists, partition studs, roof rafters and similar elements could be assembled without the additional labor required when the pieces are not uniform. Under present procedures of sawing and marketing, the following are accepted practices: (1) "Full Cut" where the pieces are cut to plus one eighth inch of the dimensions as called for; (2) "Exact Cut" where pieces are cut to the exact dimensions as called for; (3) "Scant Cut" where the pieces are cut to minus one eighth inch to a quarter inch from dimensions as called for. Fixed standard dimensions should be set for domestic merchantable lumber graded as to species and quality.

4. SUMMARY

The reserves of timber were long ago recognized by the Government as essential to its economy, and controls and reservations for conserving these natural resources were set up as early as 1856. Burma has for many years depended on this industry for most of its construction material and for its exports of wood. Many surveys, investigations and reports have been made by the Forestry Department and the State Timber Board with plans and recommendations for improvements. The urgent need at present seems to be that some of these plans and recommendations be implemented as soon as possible.

Decisions and implementation are first required with respect to extraction: (a) in regard to animal versus mechanical power; (b) with respect to an expanded program for utilization of many species of woods other than teak; (c) with respect to the development of turpentine and resin extractions from pines of the Shan States; (d) with respect to the collection and proper processing of lac for both export and domestic use; (e) with respect to better utilization of mangrove by using the bark for tannin extractions and the remainder for a distillation plant to produce industrial charcoal and many other chemical by-products. These projects have been recommended under their different headings in the manufacturing section.

B. OTHER INDUSTRIES

Preceding chapters have presented plans for productive projects in mining, manufacturing, industry, irrigation, power, transportation, communication and agriculture, involving total expenditures of K2,950 million during the next seven years. The projects planned in agriculture will directly affect only a small part of that industry. Agriculture in general and small-scale industry have also been discussed, but without project proposals, since investment in these fields will in the main be unplanned private investment.

The term investment or capital formation is apt to create mental pictures of mining or manufacturing power or irrigation, transport or communication, since these are the fields in which large aggregations of physical capital are necessary. It is important to realize that investment only in these fields would leave the development program seriously incomplete; would leave it like a structure with foundation and supporting pillars and beams, but without walls or roof. In any economy, the services performed by other industries form an essential and quantitatively important part of the processes of production and consumption; and capital formation in them forms a large part of all capital formation.

It is worthwhile to enumerate the fields of economic activity not encompassed by the planned projects. They include cottage industry and a large part of agriculture. In transportation they include the operation on inland waterways of private boats, which in the aggregate probably haul twice the volume of freight hauled by the Inland Waterways Transport Board; and the operation of buses, trucks and carts. They include all wholesale and retail trade, that is, the entire distribution and sale of the country's production other than the part exported by state enterprises. They include the entire range of private, personal and business services, legal, technical, educational, the services of hotels, restaurants, barber shops and similar establishments, motion pictures and other entertainment, and repair and maintenance services of many kinds. They include community services such as water supply, sanitation, fire protection and street improvements; housing, a very large sector; and the social services provided by the Government, which in addition to public housing include education and health and medical services. In addition there are many minor occupations and industries.

How important are these fields in the aggregate in Burma? The year 1931 is the last date for which data giving this information are available. In that year, about 70% of the labor force were engaged in agriculture. About 10% were engaged in trade and professional and miscellaneous services; about 10% in small scale industry as the major occupation; not quite 3% in education, medicine and religious practice; and not more than about 7% in all other fields.

The proportion in agriculture is perhaps smaller now, because insecurity prevents full-scale cultivation; and the proportion in services maybe somewhat greater, because many workers have drifted into unremunerative services for want of other employment. When civil order has been fully restored, the proportion in agriculture will probably be as large as before the war, since employment opportunities in non-agricultural work have not increased more than in proportion to the increase in the population and labor force. The number in services will decrease as other opportunities for employment draw off the underemployed from petty service occupations. The 1930 ratios may be taken as roughly indicative of a present "normal" situation.

They indicate that in all of the non-agricultural fields in which planned projects have been proposed, less than 10% of the labor force will be employed in the near future. The irrigation and other planned projects will affect only a fairly small minority of the total labor force in agriculture. The significance of all of the planned projects is not in the total number of workers whom they will directly employ, but in their services to the entire economy, and in their steadily increasing share of the nation's output.

Rounded and balanced economic development must allow for a large volume of investment in the many fields other than those for which planned productive projects are appropriate. For this reason investment in planned projects, of K2,950 million during the next seven years is recommended, a little less than 45% of the estimated net increase in the country's capital during the period. It is estimated that during the same period K3,650 million, or more than 55% of the total increase in the country's capital, will occur in unplanned productive projects and in community facilities and the social services.

The remainder of this chapter discusses briefly the sectors in which the 55% of total net investment will occur.

1. AGRICULTURE

In agriculture, unplanned investment will consist of construction or purchase of tools, machinery and carts, and in improvements in the land itself. To a larger extent than is commonly realized, agricultural land is the product of human labor; labor which clears the jungle and levels the land and constructs large and small embankments, roads and paths, and irrigation and drainage ditches. New agricultural methods, quite apart from sharp changes brought about by irrigation and large-scale mechanization, will involve a steady increase in the tools and machines per worker. Such capital formation will go on throughout rural Burma; it will contribute to the nation's rising output.

2. SMALL-SCALE INDUSTRY AND UNPLANNED MANUFACTURING INDUSTRY

Whether small-scale industry will employ an increasing or decreasing proportion of the nation's labor force during the next several decades can hardly be foretold. Some production will shift from cottage to factory, but on the other hand, the increase in per capita income will increase the demand for handicraft products as well as other products. The net effect is uncertain, but it is certain that cottage industries will for an indefinitely long period play an important part in the nation's production. Here too improvements in methods will involve gradual increase in the equipment used per worker. This continuing investment must form an appreciable percentage of the nation's capital formation.

Unplanned investment in manufacturing industry will also be large. The planned manufacturing industry projects recommended will constitute only a fraction of total investment in this field; much more will be contributed by private manufacturing ventures.

3. UNPLANNED TRANSPORT, TRADE AND SERVICE

Perhaps 200,000 persons are engaged in transportation, in addition to those employed by the Burma Railways and the Inland Water Transport Board. They operate the large private freight boats and the smaller country boats on the rivers, the trucks, and buses and carts on the highways. About 600,000 are engaged in trade in foodstuffs, and an added 150,000 in other trade. These 950,000 persons vary in nature from the person who operates a small cart to a large trucker; from a streetside vendor to a large speculative holder of paddy or rice. The services which they perform include bringing the nation's locally grown food from farm or garden to the towns and cities; buying the staples, transporting them to market or storage points, storing them, and delivering them to urban retail markets; importing commodities not available domestically in sufficient quantity; wholesaling; buying from wholesalers, subdividing, displaying, selling in small quantities at retail. Without them economic activity would come to a halt.

The capital involved includes boats large and small, carts, buses, trucks, warehouses and retail stores. Individual establishments are small, but the total capital formation in the tens of thousands of them is large. Smaller in number, but important in the aggregate, are the establishments providing services to business and to consumers—lawyer's offices, barber shops, hotels, restaurants, motion picture theatres and a great variety of others.

The share of the labor force and productive facilities devoted to transport, trade and services, will not diminish as Burma's per capita income rises. On the contrary, as living standards rise, a higher proportion of consumer income will be spent for services and for commodities brought to the consumer by retail trade. A larger share of the labor force will become productively employed in service and trade industries. In the United States, at the other end of the world's per capita income scale from Burma, between 40% and 50% of all productive activity is in wholesale and retail trade, transportation other than rail and river transport, the social services, and the variety of other services referred to above. The long-term trend in employment will undoubtedly be a gradually diminishing proportion of the labor force in agriculture, and a gradually increasing proportion in manufacturing and in trades and services. The total capital formation required to expand unplanned transportation, trade and service facilities as the nation grows will be much in excess of that in any one group of the planned projects recommended in this Report.

4. COMMUNITY FACILITIES

The cities and towns of the country now suffer from inadequate water supply, below-standard sanitation, and lack of community facilities. In part this is because of destruction during war and insurrection, in part because of the influx from the countryside of refugees from civil disturbance. Some of these will return to the country, but there will undoubtedly remain in the towns a population considerably larger than that before the war, and one which will grow as urbanization proceeds. The capital formation needed to rehabilitate the towns and cities and keep pace thereafter with increasing population will be considerable in amount.

5. PRIVATE INVESTMENT IN HOUSING

Finally, housing and other social services will require as much investment as almost any industrial sector. There are more than 3,500,000 housing units in the country. An estimated one half of them (constituting of course much less than one half of total housing value) are of bamboo and thatch construction. They require replacement each three to five years so that annual investment of say one fourth of their value is needed merely to keep their number constant. Others are of mixed timber and bamboo construction. The housing problem is not merely to maintain the present number. The country's supply of houses is at least one tenth below the number required to provide even the prewar standard of housing. Many families are doubled up and large numbers are still living in crowded temporary shacks without proper sanitary facilities. Even if the Government made no expenditures to improve the quality of the nation's housing, gross investment in housing would necessarily be large. The Government is, however, taking vigorous steps to improve the quality of housing, which will increase total investment in this field.

6. SOCIAL SERVICES

The Government's program to improve the social services of the country will include large capital expenditures as well as large current expenditures. While this goal of increased welfare for the nation's citizenry can be achieved in large part through improved standards of living which will result from increased incomes generated by the development program, certain goods and services, particularly those required for housing and for such social services as education and health, will not be provided in sufficient quantities unless the Government takes positive steps to provide them.

During 1952–53 a large part of government capital formation took the form of social capital such as schools, housing and medical facilities. The 1953–54 economic budget provides for capital expenditures of K70 million for social services; an amount equal to about 12½% of the planned capital expenditures. In the construction of social services facilities, perhaps the greatest progress in 1952–53 was in public housing. Construction of schools and of hospitals and health facilities also progressed.

The need for expansion of the basic educational system as well as for programs for training the specialized manpower required to man the development program has been stressed in Chapter VII. At present between 800,000 and one million children of school age attend school. Of these less than 20% progress beyond the third standard. The schools are largely staffed by non-professional teachers and are short of text-books and other training equipment. The larger share of the students learn nothing more than the rudiments of reading, writing and arithmetic.

Even so, the average worker is better educated than in most parts of Asia. The fact that more than half of the adult male population is literate makes it possible to initiate programs for vocational training and adult education much more rapidly than with an illiterate population. The Mass Education Council, the Burma Translation Society, and the Adult Education University have made important progress in starting programs to effect cultural uplift of the population. The Technical Institute at Insein, the Artisan Training Centre in Rangoon, the Rehabilitation Brigade, the Lacquer School at Pagan and the Sanders Weaving Institute at Amarapura and other institutions described in Chapter VII have also made important contributions to the task of training manpower. The emphasis on vocational training and education in science which is being introduced into the school curriculum will prepare workers for participation in the development program. Work of all of these types on a greatly accelerated scale will be required if the personnel needs of the development program are to be met.

Similarly in the field of health the need for improvement is indicated by the high death rates and the widespread incidence of preventable diseases. Malaria affects about one half the population and is endemic in about three fourths of the country. Tuberculosis, which has ceased to be a major cause of death in most advanced countries is still one of the principal causes of death in Burma and an estimated 300,000 persons are in need of treatment. An estimated 100,000 persons are affected by leprosy. Infant and maternity death rates are five to ten times the rate in most advanced countries.

The Government plans for improving health conditions include programs for control of malaria, venereal diseases and tuberculosis, establishment of maternal and child health centers, expansion and improvement of hospital facilities, and improvement of sanitary facilities. With the technical assistance of the World Health Organization of the United Nations and the United States Technical Cooperation Administration, the Government has already initiated most of these programs and has made good progress.

As in other fields, expansion of social services will be limited by the shortage of specialized manpower and skilled workers. The 1931 census indicates that only 0·5% of the labor force was classified as medical practitioners (including unregistered healers) and only 0·3% as instructors. The present percentage is no doubt roughly the same. The number of trained doctors has probably declined since before the war as a result of the evacuation of many Indian doctors. Training of large numbers of doctors, nurses, school teachers, administrators and other professional workers will be required to carry through the currently planned program for social services.

Because investigation of the means of meeting needs for social services lies outside the scope of this Report, only this summary reference is presented here. Even cursory discussion, however, makes clear the large scope of the program which is desirable, and the fact that it must include a large amount of capital formation. It is estimated that of the K6,600 million of net increase in the nation's capital during the next seven years, K700 million, or more than 10%, should be in housing (public and private) and in other social services. The estimate is apt to prove too low rather than too high. The pressure for social services is more apt to cause them to encroach on the productive projects than to fall below goals set.

7. BALANCE AMONG FIELDS

Chapter II has referred to the need for balance among the various fields of investment, including balance between social service expenditures and others. Up to the present time the problem has been minor. Resources have been idle, and expenditure for one purpose did not need to involve less expenditure for another. But as the economy becomes more fully occupied, improved housing may mean less power plant construction; manning schools and hospitals may mean failing to provide skilled or professional workers for improved production to gain increased living standards. It will be necessary to balance the immediate benefit of better social services against the benefits of increased productivity which, if attained, will permit even better social services in the future. Fortunately the leaders of Burma are aware of the need for such choices, and are prepared to weigh one benefit against another in order to aim at maximum future welfare for the nation.

CHAPTER XXV

THE COORDINATED PLAN

A. SUPPORTING FUNCTIONS*

For the development plans and the operating functions of the Government of Burma to progress vigorously and successfully, they must be economically, administratively, and technically sound in both concept and execution.

1. ECONOMIC CRITERIA

Economic problems, economic policies, and procedures for budgeting and controlling the resources of the Union have been discussed at length in the opening chapters of this Report. Specific policies have been proposed relating to taxation, price control, the uses of foreign exchange, the provision of credit, and the functions of the Economic and Social Board, the Ministry of National Planning and Religious Affairs, and the operating ministries in refining and administering these policies.

The objectives of the economic policies and operations is to support and guide the investments of material wealth in such a way that increased productivity engenders an equitably distributed rise in living standards for the people as a whole, unmarred by the dislocations of inflation or depression. To achieve this objective will require constant vigilance, continuing analysis, and prompt adaptations to both domestic and foreign economic activity. The criteria for successful economic operations should be economic policies wisely adopted, wisely pursued, and wisely reviewed.

2. ADMINISTRATIVE CRITERIA

Administrative measures, policies and operations needed to insure the determined and imaginative execution of the development program have been outlined broadly in Chapters V through VII. Specific regroupings of organizations and improvements in management have been proposed also in the chapters dealing with communications, industry, transport, irrigation, power and agriculture. There remain to be emphasized a few administrative practices and services needed to support healthy progress in all areas of the program.

a. Service Tradition

There ~~should be~~ instituted a carefully developed plan for establishing and maintaining pride in organization and traditions of service. There should be composed a code of civil service practices dealing both with relations between government employees and the public and with the relations between employees and their supervisors.

Code of Service

A code designed to promote efficient service, to improve public relations, and to strengthen the effectiveness of leadership might well be documented and distributed throughout the government service. Emphasis should be placed on a few fundamentals with illustrations of their application: for example:

Specimen Paragraphs for a Code of Service

(a) An employee of the Government of the Union of Burma is the agent of the people of Burma. His dealings with the public will be conducted in a spirit of courtesy, helpfulness, and pride in the services his organization can offer.

(b) An employee of the Union is constantly alert to find ways of improving and rendering more efficient the work of his organization.

(c) Supervisors are receptive to the suggestions of their subordinates, and are alert to reward demonstrated initiative and efficient performance by generous recognition and effective utilization of worthwhile ideas.

(d) Supervisors accept full responsibility for decisions and actions delegated to their subordinates and support the decisions and actions taken by these subordinates in discharging assigned duties.

(e) Employees in the service of the Union of Burma respect assigned channels of authority upward, recognizing that appeal to higher authority is always admissible for legitimate grievances; and downward, recognizing that to by-pass an intervening supervisor is to jeopardize the entire operation of the affected part of the organization.

(f) Corrections and improvements in the performance and operations of individuals and organizations in the Service of the Union of Burma are regularly effected by constructive suggestion, demonstration, and the provisions of needed assistance and support, but evident malingering or malfeasance in office are quickly submitted to action for dismissal by due process under the law.

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*The comments in this section are in part an extension of the discussion of Government administration in Chapter VI. They arise out of the materials of Chapters VIII–XXIV, prepared in main after Chapter VI had been completed.

Means should be provided for encouragement of adherence to the code. "Employee relations analysts" (rather than inspectors) should spot check existing conditions offering detailed and illustrated recommendations for improvement. Chronic disregard of the spirit of the code should be effectively dealt with.

An inescapable prerequisite to any program designed to build service tradition is fair and impersonal recognition of merit by promotion, added responsibility and commensurate advancements in pay. To achieve these, two conditions are necessary: one, adequate pay legislation and appropriations; and two, a corps of supervisors determined to secure for their subordinates the realization of earned advances.

General acceptance and recognition of a code of civil service practice will be facilitated by inviting representatives of the key government agencies to participate in its formulation. Each agency should also be charged with some measure of responsibility for promulgating the code and policing its practice within its own ranks.

b. Simplicity in Organizational Structure

Every governmental organization unit should have as clear-cut an assignment of functions as practicable. Its organizational structure should have few major sub-divisions in order to bring the activities within the genuine cognizance of the individual supervisor. The present large number of ministries is in itself unwieldy. When expediency permits, considerable efficiency could be gained by grouping the present number into half a dozen to ten major ministries.

c. Institutional Aids to Administration

Three institutional aids to good administration merit special mention here.

(1) Library Services

Understood to be already under consideration, a Union of Burma public library would prove invaluable to the country as a whole. Such a library located in the capital city would serve as the focal point for literary and scientific reference work, would complement the facilities of the University, would eventually provide inter-library loan services to other parts of Burma, and would be a repository for works copyrighted in Burma.

Among the many special services the library could perform, a Union Government Reference Service would contribute most directly to good administration of the development program by quickly making available books and documents on any subject from all parts of the world. For the study of mines, irrigation pumps, model making, or any of the innumerable problems that will arise in the course of diversifying industry and improving production methods in Burma, the reference service would provide selected bibliographies to officials and employees of the Government. Whether or not the Union library project is implemented, a technical reference service with broad resources should be made available to all agencies participating in the development activities.

(2) Public Information Service

The need for such a service has been mentioned previously. To provide business and industry with current information on the policies and activities of the Government would go far toward assisting private citizens as well as private enterprise in discovering required procedures for licensing, regulatory limitations, or government services applicable to their interests. As the Economic and Social Board will be in touch with all activities of the Government, affiliation of the service with that agency might be desirable.

(3) Research and Extension Foundation

Research and training in the new methods serve both the technical and administrative needs of development. Their importance has been emphasized repeatedly throughout this Report. Research is the means of bringing new methods into Burma; extension training the means of demonstrating them and their effectiveness to producers throughout the country. A central institution, furnishing stimulus and technical leadership of the highest order for research and extension in many fields, can be a focal point for elevating the goals of scientific training, insuring the availability of workers trained in original and creative thought, and assuring the steady assumption by Burma of leadership in fields appropriate to Burma's resources. One center is recommended, for even a single gifted leader at such a center can furnish stimulus in a number of fields. A study should be made of the detailed requirements for such a center, and liberal provision made for it in a future budget.

The work of such an institution might well include the following major divisions:

(*a*) *Research in physical sciences.* Pure and applied physics, chemistry, biology, mathematics, structural, hydraulic, soil mechanics, mechanical and electrical engineering; industrial development.

(*b*) *Research in social sciences.* Economics, the social services, public administration, others.

(*c*) *Extension services.* Special curricula for accelerated training, training aids for extension and in-service training; sponsorship of vocational training programs; adult education including field services in a number of fields.

An institution of this kind would provide facilities for both the short-range accelerated training so urgently needed and the long-range background of high scholarship needed to preserve the standards of attainment. The Center for Training Aids (previously referred to in Chapter VII) would assist in preparing curricula for accelerated training and course materials, slides, subject matter information and information on new methods for the use of institution lecturers, personnel of the operating ministries and others in conducting in-service training or extension work.

Engineering research laboratories would provide facilities for materials testing, river studies, structural analysis, earth-work and foundation testing, cement technology, metals and mineralogical investigations, and innumerable other studies and services. The institute for industrial research referred to in Chapter XXIV would be comprehended in this phase of the Foundation's work.

Social science research would provide information concerning modern statistical, economic and survey techniques in studying the operation of the social and economic system. It is possible, too, that accelerated training could be provided to personnel of some of the ministries in preparation for tasks of new responsibility.

The possibility should also be considered of combining into one organization the research establishments already existing or under study to facilitate the interchange of ideas and make the widest possible use of the available technical talent.

3. TECHNICAL CRITERIA

While many technical projects have been discussed in the preceding pages of this Report, little has been said of the broad criteria for insuring the technical soundness of both the development projects and the continuing productive and service activities of the Government of Burma. There are at least five requirements which must be met in this regard: adequate study, competent construction or procurement, adequate supervision, competent operation and adequate maintenance.

a. Adequate Study

The initiation and conduct of industrial, agricultural, communications and engineering activities (the extractive and productive aspects of the economy), to be successful, must be preceded by thorough and competent studies. Such studies normally entail field investigations, preliminary or master plans (such as this Report), and detailed plans, designs and specifications.

Preliminary plans and master plans (sometimes called simply "plans" in distinction from designs and specifications) should usually be sufficiently complete to determine feasibility or perhaps only to determine whether or not further expenditures for investigation are warranted. Preliminary plans are often based on fragmentary and incomplete field data, reconnaissance surveys, or partial statistical studies. Rarely, if ever, can preliminary or master plans be used as a basis for construction, procurement or operation.

Designs and specifications for construction or purchase should be the product of thorough field exploration, thorough statistical and economic determinations, thorough and scientific structural, process and equipment analyses, and thorough and accurately edited presentation. The information on which the design and specifications are based should leave no margin of doubt as to conditions affecting the location, safety, adequacy or success of the undertaking.

The finished documents, drawings and narrative specifications, though subject to revision and refinement as the work develops, should be explicit, free from ambiguity, and complete as to every feature of the work to be undertaken or equipment to be furnished.

Equipment should not be purchased without an analysis of the quantities, rates, tasks, costs and quality of work to be performed. Equipment should not be specified by vendors but by disinterested specialists in the desired operations.

As construction proceeds on a large engineering project, additional field data are gathered, designs are revised and amplified, and some additional details furnished.

b. Competent Construction and Procurement

To meet this requirement there must be, in addition to proper designs and specifications, insurance of delivery by a qualified organization. If work is to be undertaken by the Government, it must allocate time and funds to the thorough staffing and training of its organization.

For the more usual contract procedures, there must be means of selecting or qualifying bidders or candidates; there must be contract forms explicit in their references to specifications and binding as to deliveries, workmanship and performance, with bonuses or penalties where appropriate.

c. Adequate Supervision

Performance of technical operations by contractors cannot be left to the contractors' judgement. The best of specifications leave room for misinterpretation. The best of contractors' construction or organizations will favor their own convenience and profit when in doubt. Modern construction operations are therefore undertaken with an engineer organization at the site to represent the owner; to interpret the meaning and function of features and details of the work; to require compliance with the specifications; to locate, survey and measure the work; and to provide laboratory and field test services required to control the construction as it progresses.

Equipment purchases require supervision in the sense of inspection at factory, dock or site. Equipment installed may also require performance and acceptance tests. For example, a crew of four or five engineers and as many sub-professional technicians may be required to check turbine and generator performance for the acceptance of small power plant installations.

Supervision of operating activities is the implicit function of the operating organization. In general, good supervision means trained and efficient management. However, the owner or the government official responsible for the operation may find personal inspection and occasional analyses by disinterested teams of specialists necessary to evaluate or modify the performance of an operating agency.

d. Competent Operation

Depending upon the nature of the task, competent operation requires competent operating personnel and organization supported by the necessary flow of resources, adequate authority and adequate funds. The operating personnel should be qualified in their work, and should be led by supervisors who keep abreast of technical changes and are constantly seeking to improve the service while at the same time able to recognize and retain procedures and equipment of optimum value.

e. Adequate Maintenance

Too often neglected, the functions of maintenance and rehabilitation should be recognized as vital and permanent responsibilities associated with any productive activity. "Wear and tear," obsolescence, breakage, and losses are inescapable. Their rates can be statistically approximated for most activities, and proper organizations established to carry on repairs and maintain the needed flow of materials, equipment and spare parts.

In connection with such activities as highways, airports, communications and irrigation systems maintenance work assumes the proportion of major construction enterprise. It is a well-demonstrated but seldom-recognized characteristic of maintenance requirements that the constant demand for unforeseen improvements beyond the scope of literal maintenance of existing facilities imposes on the maintenance organization a continuing burden of expansion and new construction sometimes exceeding the scope of the original installation. Such requirements should be anticipated, accepted, and met by adequate staffing and appropriate equipment.

f. Ministry of Engineering Services

The library services and the Research and Extension Foundation previously mentioned would be invaluable institutional aids to the technical and functional competence of the development and operating activities of the Union. Expanded agricultural and industrial extension services mentioned in related chapters are other examples. An important long-range requirement is a greatly expanded general education program from which to draw both the specialists required to sustain an industrial economy and the informed citizenry to appreciate and defend the advantages of new and improved products.

As an additional aid to insuring adequate technical competence of the program, it is proposed that many of the civil, electrical, mechanical, mining and industrial engineering functions of the Government be grouped together in a Ministry of Engineering Services. Such a ministry should eventually be headed by an engineer of demonstrated administrative ability.

It would have the advantage of bringing together in one organization many of the varied technical talents whose combined contributions would be required on many construction projects, both large and small. It would permit the concentration, standardization, and perfection of field exploration and investigative procedures, the preparation of designs and specifications, the contracting and purchasing methods for heavy construction, mapping and hydrologic services, supervision of construction, and operating and maintenance functions of some activities.

Many types of engineering talent required in the execution of projects in one ministry are similar if not identical to those required in others. Bridge engineers are needed for irrigation, hydroelectric, industrial, mineral and communications activities. Examples can be multiplied. Their association in one organization would avoid much duplication, and would effect a vital economy in an essential area of specialized training.

An exact delineation of functions for such a ministry should be made the subject of further study. However, the following organizational groupings are suggested for initial consideration:

(1) *Department of Exploration and Surveys*

- (*a*) *Mapping section.* General mapping surveys, preparation and distribution of maps, aerial mapping and photogrammetry, hydrography, hydrographic charts.
- (*b*) *Hydrology and meteorology.* Stream gauging, water resources studies, runoff and flow forecasts, flood forecasts, groundwater measurements and records, reservoir routing, water allocations, rain gauging, thermal recordings, meteorology.

(c) *Geological survey*. Geological mapping and surveys, geological exploration for structure sites, petrographic laboratory.

(d) *Earthwork and foundations*. Site exploration, earth laboratory and testing, field laboratories during construction.

(2) *Department of Designs and Specifications*

(a) Electrical
(b) Mechanical
(c) Highway
(d) Industrial
(e) Structural
(f) Dams
(g) Municipal
(h) Specifications and contracts.

(3) *Department of Construction*

(a) Inspection
(b) Contract adjustments
(c) Field service.

(4) *Department of Operations and Maintenance*

(a) Highways
(b) Irrigation
(c) Power
(d) Communications.

It is recommended that a more detailed examination be made of the possible economies and improvements afforded by a Ministry of Engineering Services as a means of materially facilitating the implementation of the development program.

g. Aerial Surveys

As an example of a detailed report on a segment of the organization that would be included in a Ministry of Engineering Services, there follows a discussion of the present and recommended status of the program for aerial mapping.

(1) The Preliminary Report

In initiating the resource inventory of Burma it was realized that aerial photography of potential development sites would be essential to provide basic data for investigative studies. Further, it was recognized that agricultural studies, including land use and soil capability surveys, could efficiently be made of extensive areas only by employing aerial photography.

Accordingly the Preliminary Report recommended "the complete aerial photo coverage of the agricultural land of the country." Additionally, in connection with ports and waterways surveys, the Preliminary Report recommended that "aerial photographs should be made during the low water season to determine the present conditions on the principal waterways."

(2) Related Aerial Survey Needs

With the realization that appropriate aerial photography would facilitate investigative or development studies in connection with many other activities, government agencies were contacted, needs were considered and, as a result, requests for aerial photography were made by nine agencies aggregating more than 200,000 square miles.

To satisfy this obvious need an aerial survey program was planned.

(3) The Aerial Survey Program (Project Proposal No. 73)

The comprehensive aerial survey program for Burma was evolved early in 1952. The proposal (Project Proposal No. 73) was approved by the Burma Economic Aid Council on April 30, 1952, and forwarded through TCA Burma to Washington where it was subsequently approved. In Washington, TCA funds in the amount of $1,100,000.00 were allocated to the program and plans were made for implementation.

The planned objective of the aerial survey program is:

(a) To secure aerial photography of the whole of Burma at such scales as to be suitable for various uses, together with mosaics and topographic maps of specific selected areas, and to organize, equip and train a nucleus organization of a permanent unit for operations essential to the effective use of the aerial photography and the preparation of multiple purpose maps.

(b) To secure magnetometer surveys, comprised of the necessary aerial photography, airborne magnetometer data, and the resulting geophysical maps suitable for mineral location and development studies in specifically designated areas.

The original program proposed that all of Burma would be photographed within five years although it was acknowledged that the rate of coverage would be governed by the urgency of need, and that considerably more time might lapse before photography of some of the more remote areas could be justified. During the first year (fiscal year 1953) it was proposed to photograph approximately 50,000 square miles and to secure magnetometer surveys of approximately 12,000 miles.

(4) Uses

(a) Photography. Exclusive of the many possible military uses of the aerial photography which will not be discussed here, the photography procured under this program will be used specifically:

(1) *As a library*

In the use of reference photography it is not uncommon to plan a systematic stereoscopic study of photography covering extensive areas with a view to observing and cataloging any anomalies encountered, terrain types, cover, geological features, erosion or flood conditions, transportation possibilities, unusual population conditions, obvious industries, and numerous other matters.

(2) *For multiple-purpose topographic and cadastral maps*

Strictly modern mapping, ranging from the large-scale, two-foot contour interval map of industrial area, factory site, or intricate urban development to small-scale maps of large or remote areas of difficult access, employs and is admittedly dependent upon aerial photography as the only source of comprehensive detail susceptible of accurate assembly by photogrammetric techniques. Common practice in many countries has made the procedure for procuring aerial photography and the related ground control routine as the first step in any mapping program.

(3) *For agricultural development programs*

A major part of the area of the United States has been photographed for use in connection with agricultural programs. Generally enlargements at scales of 1,000 or 1,320 ft. to an inch are taken to the field for the correlation of data on soil studies, land use, crop control and field areas. The use of the photography in this way has become such an accepted practice that entirely new procedures would have to be developed if aerial photographs were not available. It is inevitable that available aerial photography will fit equally well into any development studies in connection with Burma agriculture.

(4) *For surveys and control of soil erosion*

The Shan States Erosion Control has urged that aerial photography be furnished for use in combating soil erosion. This is in line with modern practice. Erosion control requirements and possibilities are apparent in the bird's-eye view provided by aerial photography, which shows the extent of damage and sometimes the cause.

(5) *For the study of surface geology*

Interpretation of surface geology from aerial photography is the work of a specialist. Geologists practiced in stereoscopic study are frequently able to make valuable surface studies of a reconnaissance nature. The interpretation possibilities vary with the type of terrain, amount of cover, depth of overburden, and prominence of the geological structure. It is, however, sometimes possible to trace faults, strikes, or outcrops even in areas of heavy jungle cover where evidence on the ground might be discovered only by accident or at the expense of great time and effort. An important feature in the study of surface geology by aerial photography is the possibility of eliminating large areas from further consideration. Conversely, the photographic study may point to definite potentialities justifying additional exploration on the ground.

(6) *For the inventory of forest resources for stock maps*

The Department of Forests of Burma has for years made use of any available photography in connection with forest administration. Timber typing and assessment of forest products from aerial photography is now a well-developed technique. Accordingly, the foresters view the aerial survey program as a welcome means of supplementing the basic forest data.

(7) *For route reconnaissance*

Preliminary location surveys for highway, railroad, transmission line and pipeline alignments, particularly problems involving alternative possibilities, long distances, remote areas, or difficult time schedules, are now commonly made by use of aerial photography. Depending on the objective, location procedures for any of these may require only simple stereoscopic study to assess the comparative advantages of possible locations. In some cases actual preliminary location may be made in the field directly from aerial photography as in the case of the survey for a large oil pipeline made recently through more than 600 miles of western Canada mountains. Not infrequently, actual topographic strip maps are made by photogrammetric methods to such accuracy that locations are projected, quantities computed, costs estimated, and comparative advantages of alternative locations measured in terms of ultimate cost.

(8) *To facilitate waterway studies*

It is not contended that hydrography can be obtained from aerial photography. However, the base map upon which the waterway hydrography is indicated is frequently an expensive and time consuming job by ground methods. Tracing the sinuosities of channels, inlets, tide flats and bars is routine in mapping by photogrammetric methods, and in addition, the photography provides stereoscopic study for waterways investigations. Shoals, intricate channels, cutting action, old channels, tendencies toward channel changes, all are evident in detail, and permit an estimate of causes of destructive water action and the planning of corrective measures.

(9) *For urban planning*

For the construction of freeways, extension of railroads, widening of thoroughfares, or rerouting of bus services, the planner needs a broad perspective of the urban area to judge the advantages of various possibilities and probable effects of proposed action. In determining the most suitable location for public parks, schools and playgrounds, it is important to consider the distribution of the residential zones and the approximate population density within each zone. An additional determining factor is the location and topography of the open spaces in which schools, parks or playgrounds might be located. It has been demonstrated that aerial photographic interpretation supplemented by necessary information derivable only from ground study, provides an economical means of obtaining the comprehensive data necessary for locating the facilities in question.

When aerial photography is used to solve development problems, speculators and the general public are not aware that an inventory of conditions is being made. When such surveys are made by ground methods so much interest is frequently aroused that property values may be unduly inflated or political pressure aroused, for or against, the project without regard to its merits.

Since aerial photographs do not show locations of subterranean structures such as subways, sewers, storm drains, or communications cables, they do not take the place of maps. However, because of the wealth of detail available, annotated aerial photographs will in many cases be of much more use than the best of maps.

(10) *For special purpose maps*

As the source of data for special purpose maps, aerial photography is recognized as essential in many present-day heavy construction projects. By employing modern photogrammetric techniques the high-accuracy large-scale topographic maps needed for areas of construction-site importance can usually be made more economically and very much more rapidly than by conventional ground methods.

(11) *Not as map substitutes*

Much has been written recently about the use of aerial photographs as map substitutes for portraying features of the earth's surface. However, it should be emphasized that a single pair of aerial photographs in the hands of a competent interpreter reveals far more information than a map can show relative to such diversified fields as geology, forestry, agriculture, engineering and geography. Furthermore, the aerial photograph portrays this wealth of information regarding the earth's surface in a completely unbiased fashion and in conformity with well-known mathematical and physical laws. For these reasons, perhaps aerial photographs should not be considered as a *substitute* for anything—not even a map.

(b) Magnetometer surveys. In Burma, as in many other tropical to subtropical countries, ground geological exploration is handicapped by physical conditions which render the routine methods of the past backward, time consuming, and insufficiently productive except where comparatively small areas are to be explored. Because of topography which renders access very difficult, forest and jungle-covered terrain, thick overburden, and other physical conditions which conceal outcrops and ore indications, many areas which might contain valuable ore deposits have never been reconnoitered.

It is under such conditions that aerial photography and new geophysical methods make prospecting of certain areas not only possible, but economical, expeditious and revealing. Of the various methods available, the airborne magnetometer reconnaissance survey has been considered potentially the most productive for initial use in Burma. With properly planned survey, the data obtained with the magnetometer will permit geological and geophysical ground examinations, drilling, and other exploratory work.

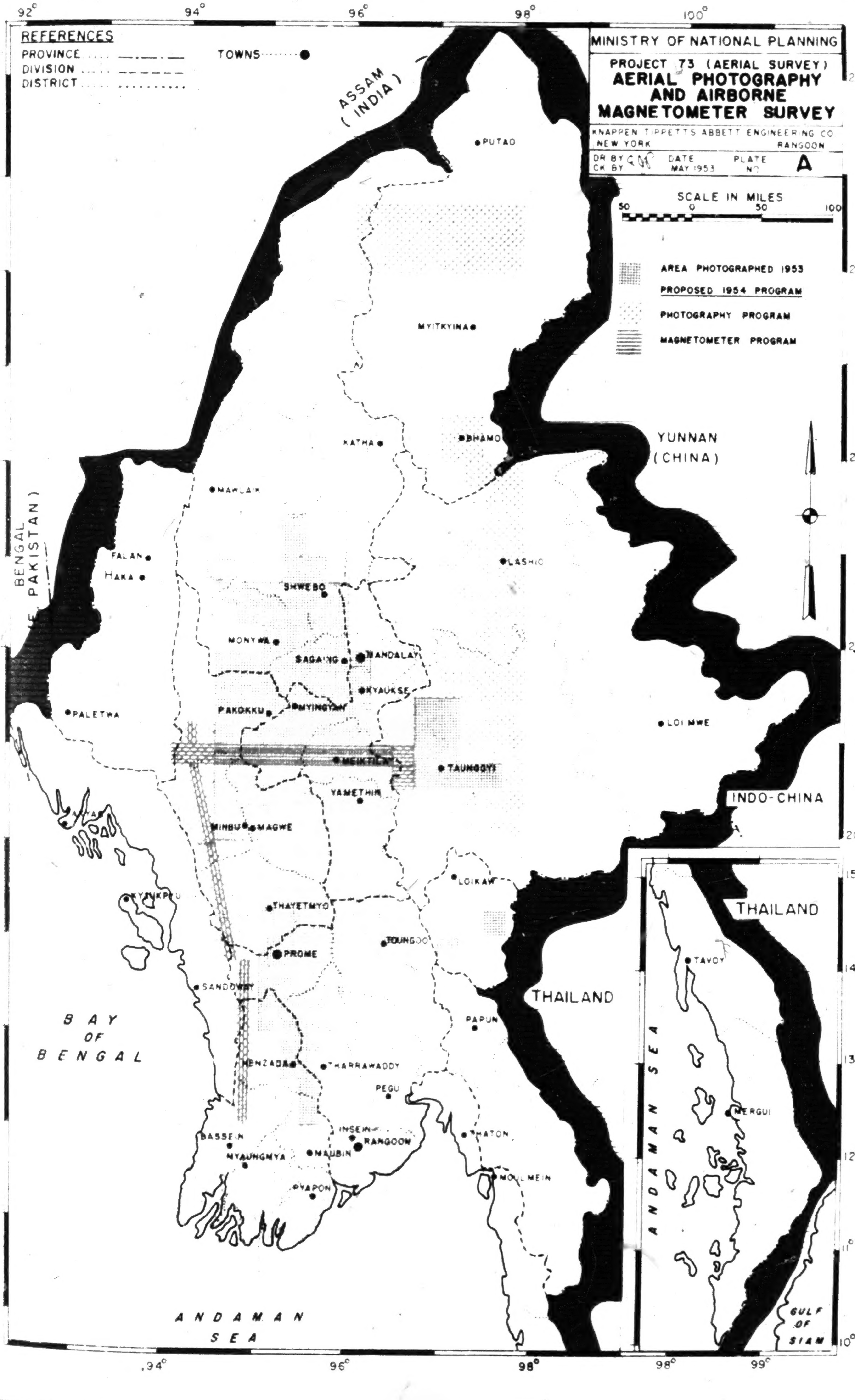
In Burma, where such large sections of the country are unexplored, and where the deposits which have been so advantageously exploited indicate a good expectancy for further discoveries, it is almost impossible to overemphasize the economic value of aerial photography and magnetometer reconnaissance surveys as first measures in securing the rapid and efficient development of mineral resources.

(5) Related Supplemental Projects

While Project Proposal 73 was being initiated, contracts were made with Hunting Aero Surveys of London, and with Air Survey Company of India Ltd. for the procurement of urgently needed aerial photography of various small areas to facilitate immediate studies of proposed projects.

(a) By contract with Hunting Aero Surveys, aerial photography of five proposed hydroelectric sites was procured. Catchment and reservoir areas were photographed at an average scale of 1 : 24,000 supplemented by photo-coverage of possible dam sites at approximately 1 : 12,000. The following tabulation shows the cost of this work.

Item	*Area Sq. Mile*	*Scale*	*Cost*	*Per Sq. Mile*
			K	K
Pegu	317	1 : 24,000	10,206	32
..	44	1 : 7,920	11,586	263
Mon	260	1 : 24,000	9,510	37
..	43	1 : 12,000	8,493	193
Lampha	76	1 : 24,000	5,117	67
..	14	1 : 12,000	5,018	358
Namtu	160	1 : 24,000	9,363	59
..	34	1 : 12,000	10,197	300
Balu	102	1 : 24,000	7,834	77
..	18	1 : 12,000	7,636	420



MINISTRY OF NATIONAL PLANNING

PROJECT 73 (AERIAL SURVEY)

AERIAL PHOTOGRAPHY AND AIRBORNE MAGNETOMETER SURVEY

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON

DR BY GM
CK BY
DATE MAY 1953
PLATE NO A

REFERENCES
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AREA PHOTOGRAPHED 1953
PROPOSED 1954 PROGRAM
PHOTOGRAPHY PROGRAM
MAGNETOMETER PROGRAM
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98°
100°
28°
26°
24°
22°
20°
ASSAM (INDIA)
PUTAO
MYITKYINA
BHAMO
KATHA
YUNNAN (CHINA)
MAWLAIK
BENGAL (E. PAKISTAN)
FALAM
HAKA
LASHIO
SHWEBO
MONYWA
SAGAING
MANDALAY
KYAUKSE
PAKOKKU
MYINGYAN
PALETWA
MEIKTILA
TAUNGGYI
LOI MWE
YAMETHIN
INDO-CHINA
MINBU
MAGWE
KYAUKPYU
LOIKAW
THAYETMYO
PROME
TOUNGOO
SANDOWAY
THAILAND
BAY OF BENGAL
PAPUN
HENZADA
THARRAWADDY
PEGU
BASSEIN
INSEIN
RANGOON
THATON
MYAUNGMYA
MAUBIN
MOULMEIN
PYAPON
ANDAMAN SEA
15°
14°
13°
12°
11°
10°
THAILAND
TAVOY
MERGUI
ANDAMAN SEA
GULF OF SIAM
98°
99°

In summary, this consisted of : 915 square miles of 1 : 24,000 photography at K46 per sq. mile and 153 square miles of large-scale photography at K280 per sq. mile. These surveys were made for the preliminary investigations on the Pegu and Balu Chaung sites.

(b) Air Survey Co. of India Ltd. furnished aerial photography of industrial sites and mineral areas at the cost shown below:

Item	*Area Sq. Mile*	*Scale*	*Cost*	*Per Sq. Mile*
			K	K
Myingyan	70	1 : 12,000	5,600	80
Monywa	15	1 : 12,000	1,650	110
..	25	1 : 12,000		
L[illegible]ghkeng	50	1 : 24,000	3,250	43
Akyab	6	1 : 12,000	660	110
Plus mobilization charge			1,500	
Plus standby charge			5,000	
Totals (166 sq. miles)			17,660	106

Aerial photography had been previously obtained for the Saingdin Falls site on the Saingdin River and for the Bawgata project. Security conditions have delayed the establishment of ground control for topographic mapping but mosaics were prepared of the Myingyan and Monywa areas which serve for the initial investigation of these sites. The preliminary studies of the Akyab paper mill site are being made largely from the aerial photographs.

(6) Synopsis of Operations

To initiate aerial surveys during the 1953 dry season a contract was entered into with Worldwide Surveys Inc., of Philadelphia, dollar costs in the amount of $735,000·00 having been made available through issuance of a letter of guaranty by TCA. The contract provided for operations for two seasons and proposed, during the 1953 season, to procure aerial photography of not more than 60,000 square miles, and magnetometer surveys not exceeding 6,000 linear miles. Two aircraft and photographic crews, photolaboratory equipment and technicians were mobilized at Rangoon in early January 1953, and photographic operations were begun at once.

Initial operations were conducted from Rangoon until February 7, when the field base was moved to Meiktila, and photographic operations continued. On April 20, the aerial photographic crews were interseasonally demobilized having accomplished, during the preceding 106 calendar days, approximately 40,000 square miles of aerial photography (see Plate A).

No magnetometer surveys were obtained during the 1953 season but provisions were made to give this work a high priority during 1954 operations. Production of delivery prints and indices required under the contract was started upon demobilization of the photographic crew and should be completed late in September 1953.

(7) Costs

(a) 1953. Field operations during the 1953 season, together with the estimated costs of laboratory charges and delivery items will obligate $333,000 of the contract fund, leaving an approximate balance of $402,000 for the 1954 season.

(b) 1954. The program for 1954 contemplates photographing 52,500 square miles, and completing 6,000 linear miles of magnetometer surveys.

Estimates based on 1953 accomplishments indicate that this will cost approximately $475,000. Accordingly, if weather permits photographic operations as estimated, a full season's work with two aircraft might obligate dollar costs in the amount of $73,000 in excess of the presently available balance. In the interests of ultimate economy, the Government should be prepared to guarantee such an overrun.

(c) Local currency. To facilitate the program, the Government provided a kyat account to reimburse the contractor for local currency expenses. This account provides for laboratory space and facilities, travel in Burma, quarters and cost-of-living allowance for the contractor and personnel, clerks, interpreter and local assistants at an average cost of approximately K30,000 per month.

(8) Summary of Costs

(a) Aerial photography. The cost data shown below have been computed on a basis of the 40,000 square miles of photography obtained during the 1953 season and on the premise that an additional 52,500 square miles will be photographed during the 1954 season.

SUMMARY IN DOLLARS

	Dollar Cost	*Kyat Cost*	*Total*	*Per Sq. Mile*
	$	$	$	$
F.Y. 1953	332,826.51	44,210	377,036.51	9.43
F.Y. 1954	327,965.89	44,210	372,175.89	7.09
Total	660,792.40	88,420	749,212.40	8.10

SUMMARY IN KYATS

	Dollar Cost	*Kyat Cost*	*Total*	*Per Sq. Mile*
	K	K	K	K
F.Y. 1953	15,80,926	2,10,000	17,90,926	44.77
F.Y. 1954	15,57,838	2,10,000	17,67,838	33.67
Total	31,38,764	4,20,000	35,58,764	38.49

(9) Fiscal Year 1954 Aerial Photography Program

(a) Re-flights. Approximately one third of the re-flights required in connection with the 1953 operations were incomplete at the end of the photographic season. In line with orderly prosecution of the work, to permit completion of the affected quadrangle indices, and to complete the affected units with as little difference in date of photography as possible, one aircraft and crew will be assigned to the task of completing ordered re-flights. This involves widely scattered flight strips aggregating approximately 3,000 square miles of photo-coverage.

(b) Photography for magnetometer areas. Photography has been considered necessary in order to obtain the magnetic profiles, it being reported by the contractor that the conventional one inch to one mile maps do not contain sufficient detail to permit following a predetermined flight line when flying at low altitudes.

Accordingly, since magnetometer surveys will be given a high priority in the 1954 season, one plane will be assigned the task of securing photography of any areas scheduled for magnetometer surveys which have not yet been photographed. On a basis of the presently proposed magnetometer surveys this will involve photography of approximately 6,000 square miles.

(c) Continuation of the blanket coverage program. The areas to be photographed and the priorities of operations will be designated by the Government; however, the selection areas and priorities will be governed by the indicated needs of the various using agencies which have been requested to submit their considered requests for aerial photography. In line with the plan to obtain blanket coverage of the country, the various items will be laid out in as large blocks as practicable, governed, however, by the number and urgency of requests for specific areas. It is estimated that completion of the F.Y. 1954 program will account for an aggregate total of 92,500 square miles or approximately 35% of the area of Burma.

(10) The Related Photogrammetric Training Program

The original aerial survey program proposed to train the nucleus of a photogrammetric engineering force to the end that the aerial survey unit can function efficiently as a permanent service organization in the compilation of base maps from aerial photography for either general or specific purposes. In addition, it proposed training the unit in the graphic techniques incidental to the making of mosaics, planimetric maps, or other special purpose photogrammetric operations.

To make this training possible, modern photogrammetric and laboratory equipment has been ordered through the cooperation of TCA at an estimated expense of $68,000.00 (K3,23,000.00). One photogrammetrist has been provided through TCA for a period of two years to instruct trainees in photogrammetric techniques on actual production problems. He will be assisted by two technicians from the Survey Department who have been undergoing an intensive course in photogrammetry in London during the past year.

In addition, a laboratory technician is being provided for instructing trainees in the various related laboratory operations, and it is probable that the services of three photo-interpretation experts will be made available to assist in training in the application of aerial photography in the fields of geology, agriculture, and urban planning. Actual implementation of the training program in basic photogrammetry and graphic techniques is only awaiting availability of suitable space.

(11) Recommendations

(a) Aerial photography. Generally one use is sufficient justification for procurement of aerial photography. Here there are 12 agencies submitting overlapping requests for aerial photography based on their considered needs. With the knowledge that the economy of securing photography for resource inventory and for demonstrated needs is sound, it is recommended that the program of securing aerial photography of all of Burma be continued with the target of completing the coverage within the next seven years.

Because the demand for photography of some of the more remote areas will not be immediate, the yearly program will fluctuate. However, in the interests of operational economy, it is suggested that an effort be made to program 30,000–50,000 square miles per year.

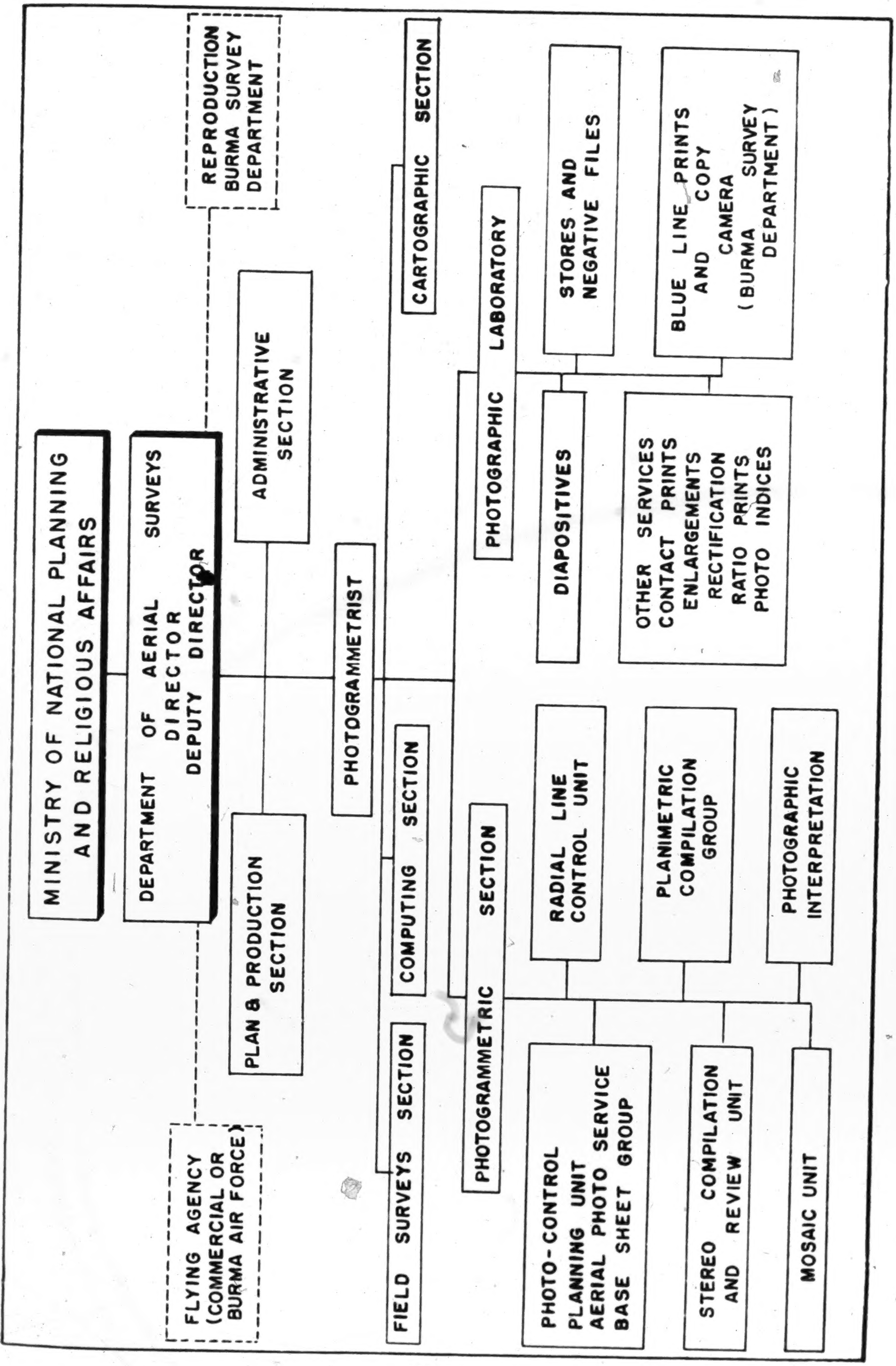
(b) Airborne magnetometer surveys. The results of magnetometer surveys cannot immediately be evaluated, since the data thus assembled must be correlated with the geology of the area. Accordingly continuance of the magnetometer surveys must be governed by the results obtained during the 1954 program. Additional magnetometer surveys are not recommended at this time.

(c) The photogrammetric organization. Governments normally provide the various special purpose maps required by their agencies and public. Because speed of compilation and accuracy of portrayal are important, an adequate photogrammetric unit is indispensable.

Accordingly it is recommended:

(1) That adequate quarters be made available, comprising not less than 10,000 sq. ft. initially,

PLATE B


MINISTRY OF NATIONAL PLANNING AND RELIGIOUS AFFAIRS
DEPARTMENT OF AERIAL SURVEYS
DIRECTOR
DEPUTY DIRECTOR
FLYING AGENCY (COMMERCIAL OR BURMA AIR FORCE)
REPRODUCTION BURMA SURVEY DEPARTMENT
PLAN & PRODUCTION SECTION
ADMINISTRATIVE SECTION
PHOTOGRAMMETRIST
FIELD SURVEYS SECTION
COMPUTING SECTION
CARTOGRAPHIC SECTION
PHOTOGRAMMETRIC SECTION
PHOTOGRAPHIC LABORATORY
PHOTO-CONTROL PLANNING UNIT AERIAL PHOTO SERVICE BASE SHEET GROUP
RADIAL LINE CONTROL UNIT
STEREO COMPILATION AND REVIEW UNIT
PLANIMETRIC COMPILATION GROUP
MOSAIC UNIT
PHOTOGRAPHIC INTERPRETATION
DIAPOSITIVES
STORES AND NEGATIVE FILES
OTHER SERVICES
CONTACT PRINTS
ENLARGEMENTS
RECTIFICATION
RATIO PRINTS
PHOTO INDICES
BLUE LINE PRINTS AND COPY CAMERA (BURMA SURVEY DEPARTMENT)

suitable for housing delicate scientific instruments and related mapping operations.

(2) That personnel be selected on the basis of aptitude tests to staff the organization outlined on the organization chart (Plate B).

(3) That production-training be initiated without delay to include basic fundamentals, photo interpretation, graphic techniques, ground control, stereoscopic plotting, map compilation, and the related laboratory operations.

(4) That serious consideration be given to organizing, equipping and training one or more aerial photographic crews.

(5) That the operations of the photogrammetric unit be conducted in closest cooperation with the Burma Survey Department with view to merging with that Department at the end of an appropriate training period, tentatively set at two years, to complete the modernization of a service organization for the capable handling of surveying, mapping and related activities, for the Government of the Union of Burma.

B. THE COMBINED PROGRAM

1. PROGRESS RATES

The goal of the development program is to raise the gross national product from K465 crores per year in 1952–53 to K700 crores in 1959–60. To accomplish this increase it is estimated that approximately K660 crores, in addition to expenditures already made in 1952 and 1953, will be spent on rehabilitating existing and developing new cultural and physical assets in the intervening period of seven years. The program does not start from zero and end at the predetermined goal, for advances are being made now, and will continue after the projects outlined in this Report have been completed. The program proposed herein should be considered as superimposed on the normal rate of development as a means of accelerating the attainment of an improved standard of living. Economic conditions that govern the welfare of society are never static; they progress in proportion to the collective efforts of individuals and nations to improve, and retrogress when the effort is lacking.

2. DIRECT AND INDIRECT RETURNS

The program includes projects for which the returns may be measured by increased Union income and those for which the returns are just as important but are not susceptible to measurement in monetary values. In the first category is the development of the agricultural, mineral and water resources of the country, and the improvement of means of transportation and communication. In the second category are public health and welfare, education and other cultural activities. The activities included in the two categories are interdependent. One cannot progress without progress being made by the other.

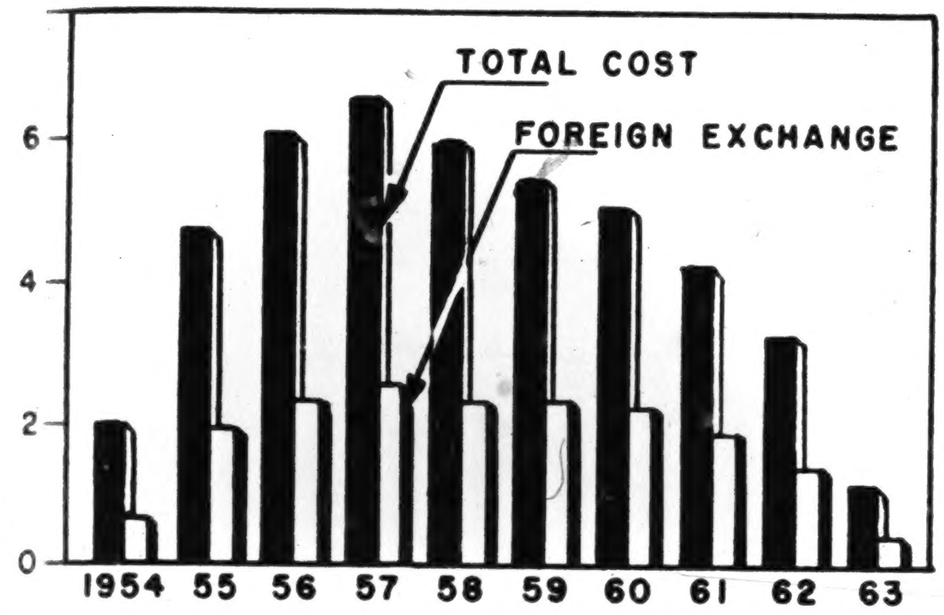
3. ECONOMIC AND MANPOWER BALANCE

The estimated expenditure on specific projects in the first category of the program is approximately K350 crores during the seven-year period. It is essential that these projects be carefully scheduled and that the schedule be followed in order to keep the program in balance.

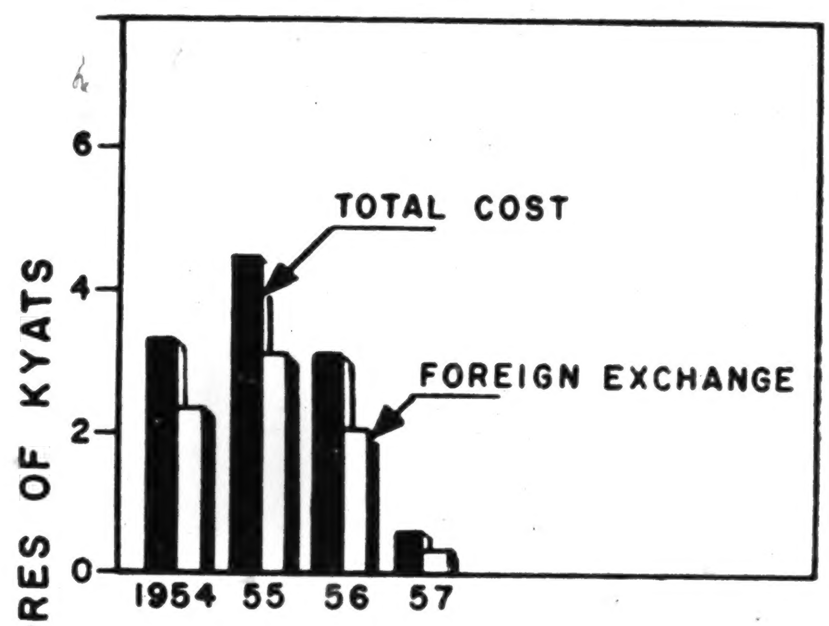
In Table XXV–1 (*see p.* 836) are shown the estimated costs and the distribution of expenditures for all the specific projects through the years 1953 to 1960. The totals are shown graphically on Plates 1A, 1B, and 2. The manpower requirement is also shown on Plate 2. The peaks of both expenditures and manpower utilization occur in the years 1956, 1957 and 1958.

It would be unrealistic to ignore slippage in programmed execution. Based on experience elsewhere, a slippage factor of 50% in the initial years would not be unreasonable to expect. Such a slippage would tend to flatten and displace the peaks toward later years. Practical considerations therefore lead to the conclusion that manpower shortages will not, in fact, develop.

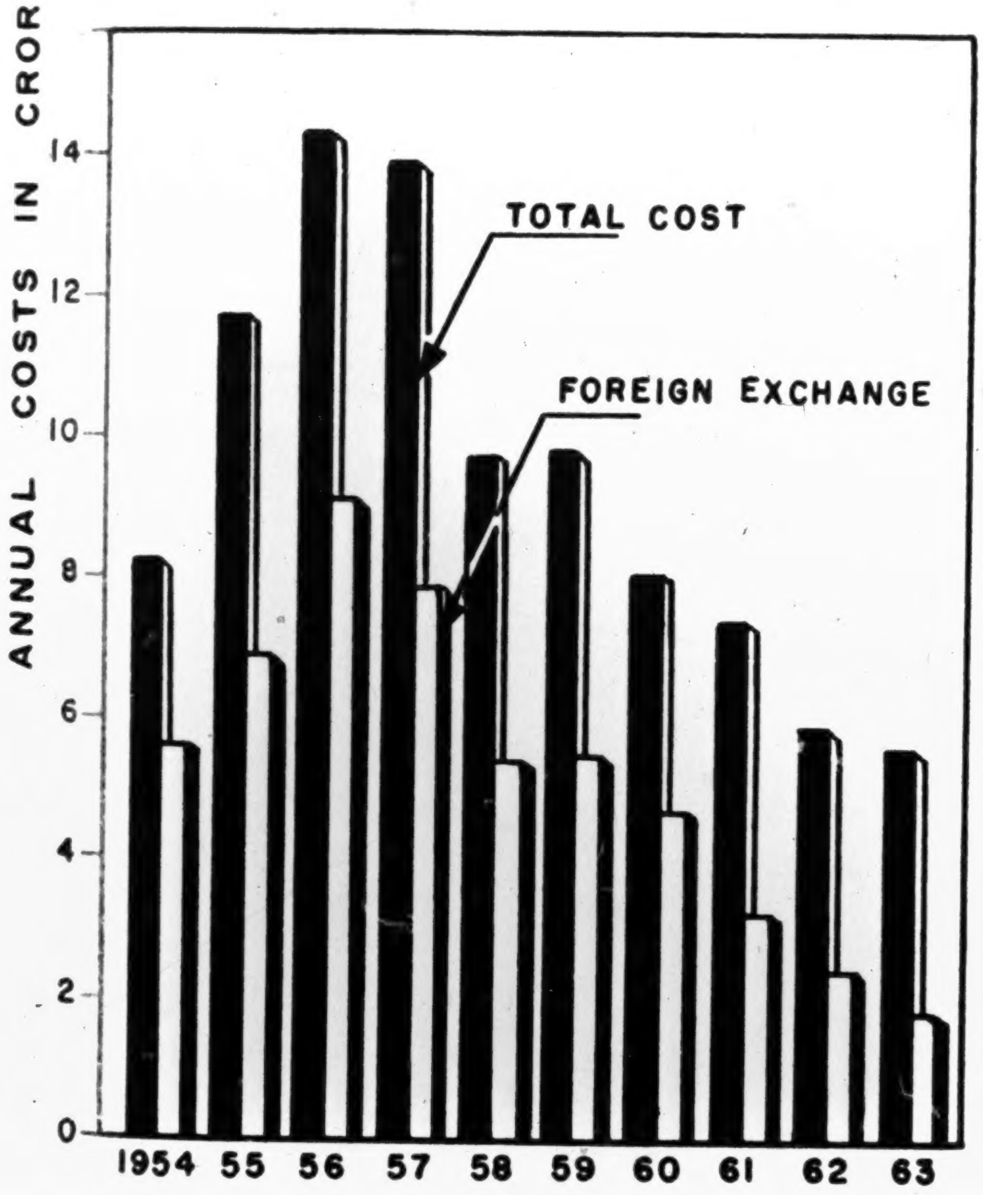
In conclusion, it should be emphasized that whereas the combined program is almost infinitely flexible, certain projects and groups of projects are closely interdependent. The inevitable dislocations arising from both human error and physical failures should be carefully studied and countered to prevent the possibility that any supporting project might fail to be completed in time to service another project which may be dependent upon it.



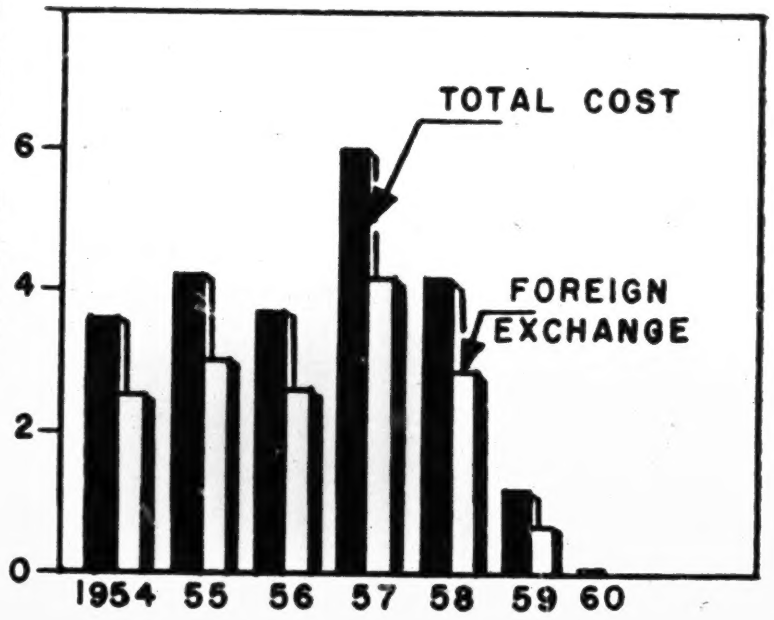
IRRIGATION



MINING



POWER



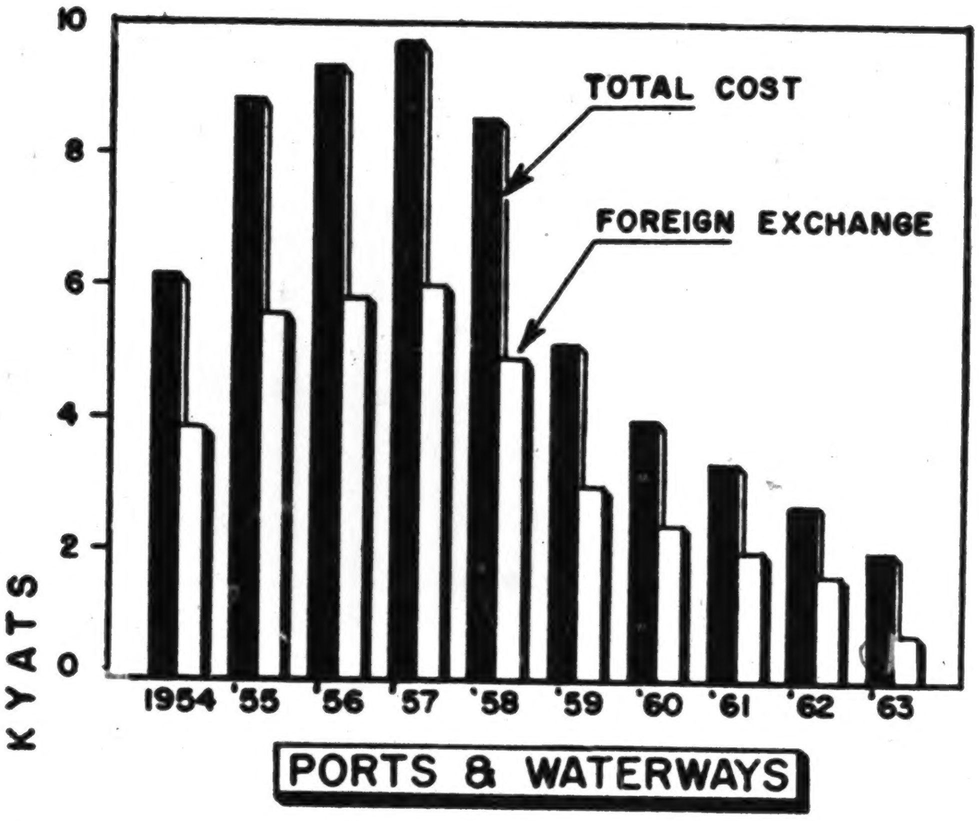
INDUSTRY

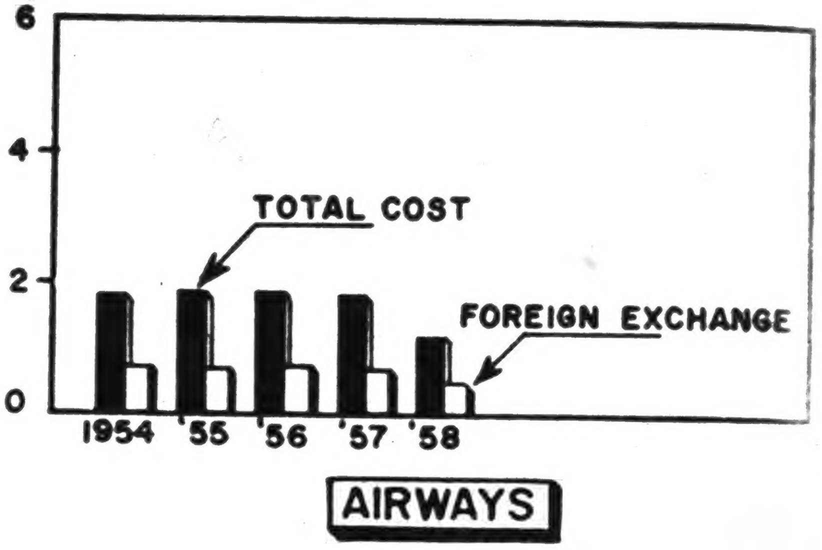
MINISTRY OF NATIONAL PLANNING

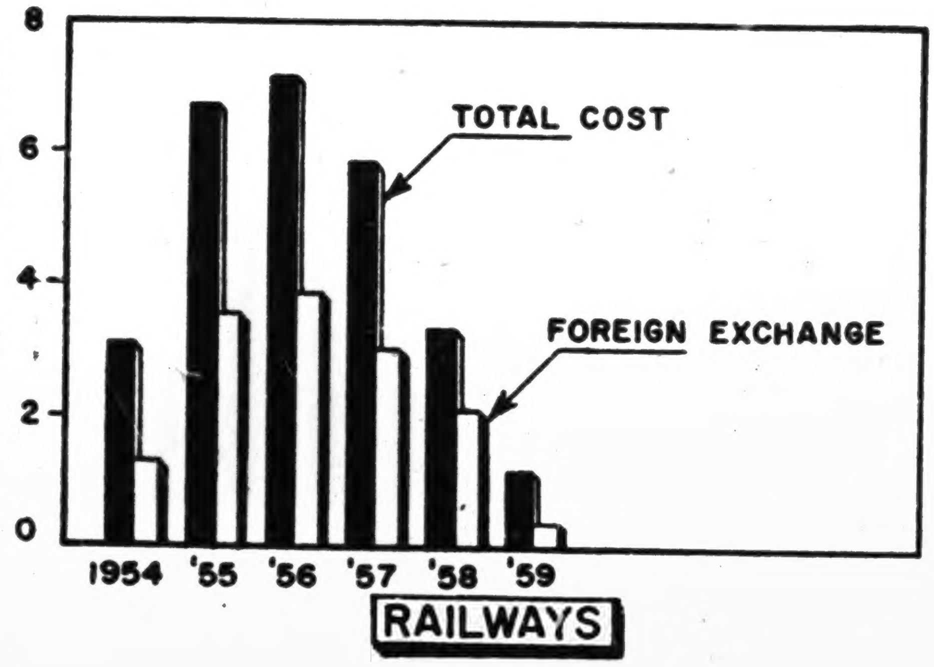
ESTIMATED TOTAL DEVELOPMENT COSTS & FOREIGN EXCHANGE 1954 TO 1963 INCLUSIVE

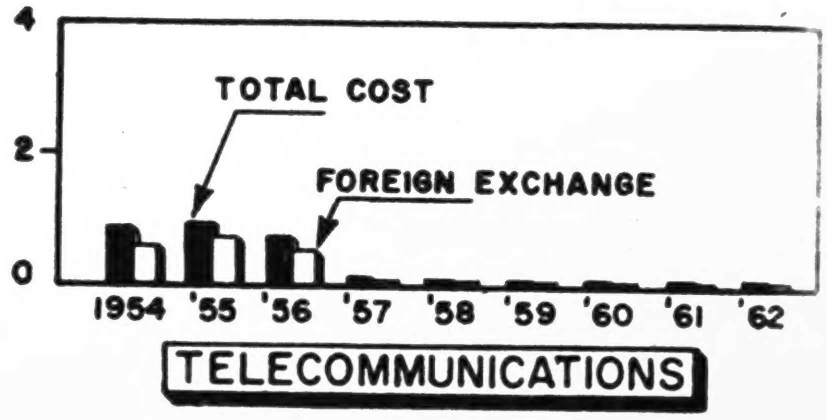
KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON

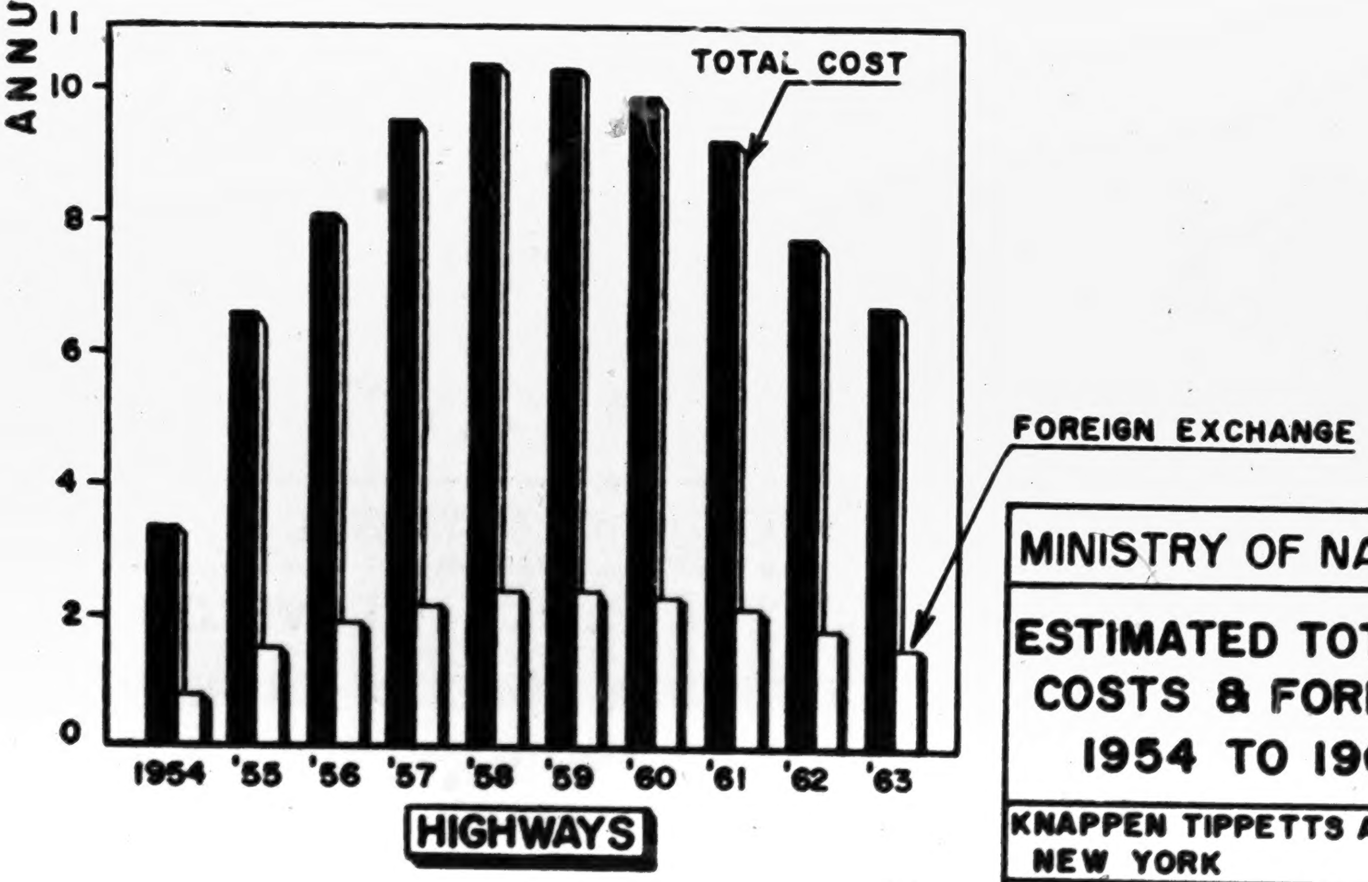
DR. BY. E J P DATE PLATE
CK. BY. J B A JULY. 53 NO. 1A.









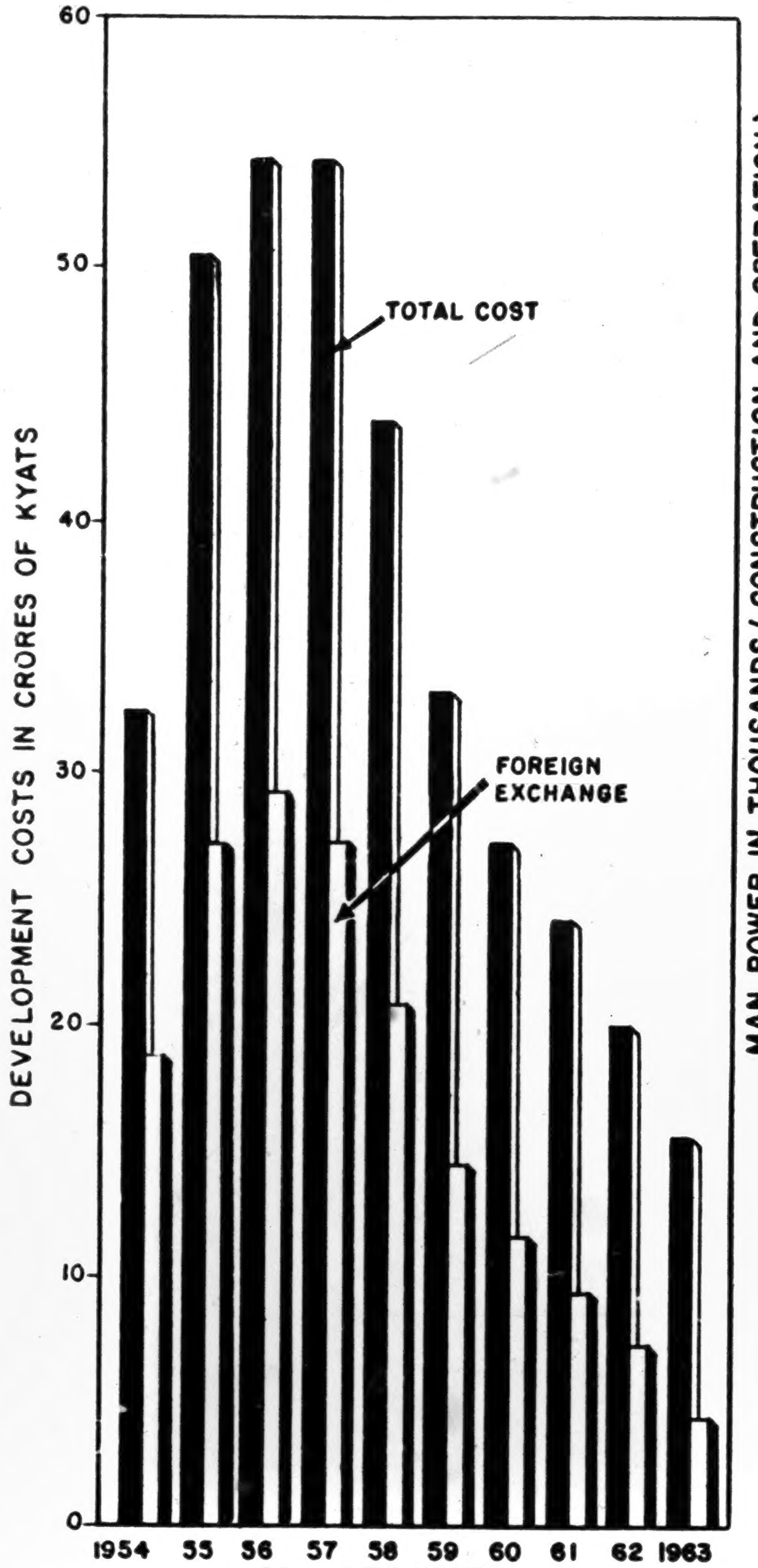


MINISTRY OF NATIONAL PLANNING

ESTIMATED TOTAL DEVELOPMENT COSTS & FOREIGN EXCHANGE 1954 TO 1963 INCLUSIVE

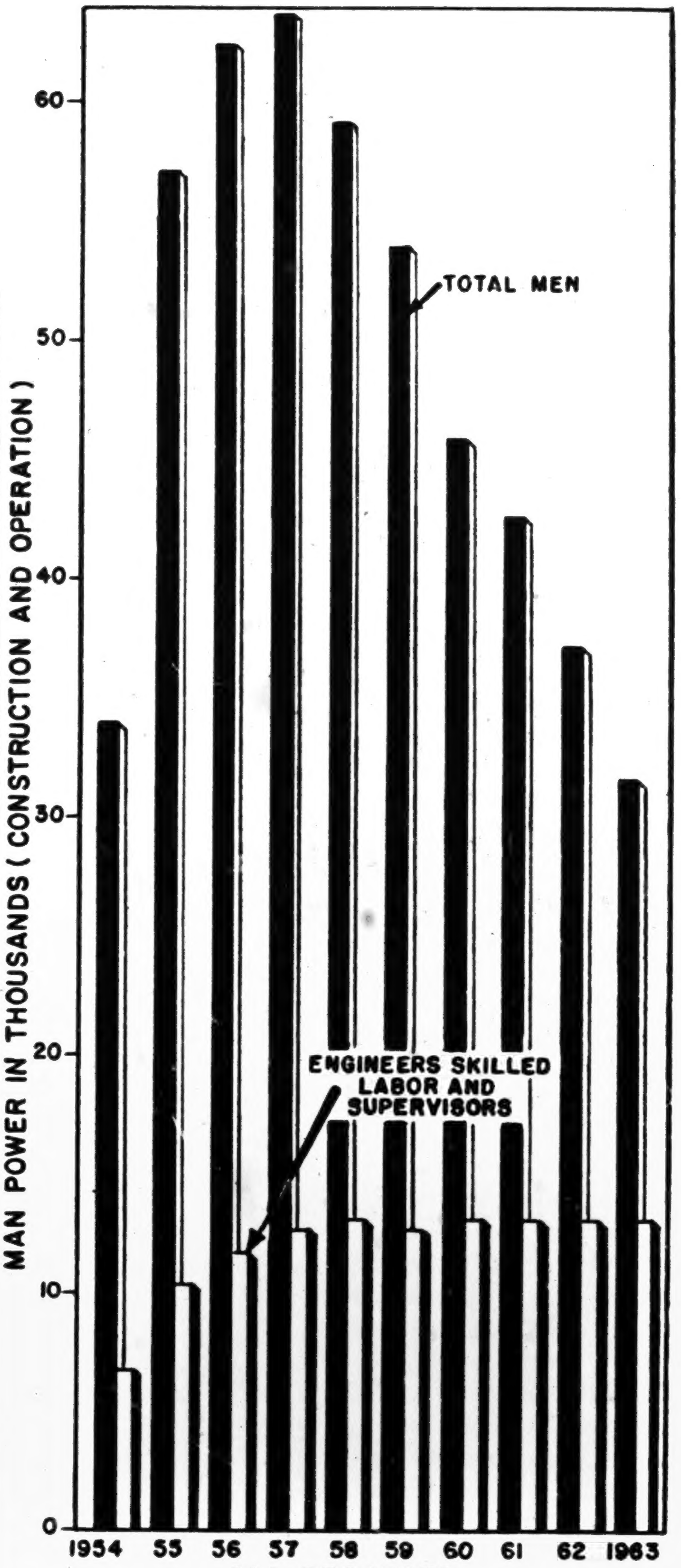
KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY *E.J.P.* DATE
CK. BY *J.B.A.* JULY 53
PLATE NO. 1B



ALL PROJECTS

DEVELOPMENT COSTS AND FOREIGN EXCHANGE



ALL PROJECTS

NEW JOBS ON CONSTRUCTION AND OPERATION OF THE RECOMMENDED PROJECTS

MINISTRY OF NATIONAL PLANNING

ESTIMATED DEVELOPMENT COSTS AND MANPOWER NEEDS 1954 TO 1963 INCL.

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK. RANGOON

DR BY. E.J.P. DATE
CK BY. J.B.R. JULY 53
PLATE NO 2

TABLE

SCHEDULE OF PROJECTS IN

(*Costs in*

	*Estimated Total Cost**	*1953-54*	*1954-55*	*1955-56*
POWER DEVELOPMENT				
Diesel Electric Plants	11,93,13	2,37,00	4,00,00	4,56,13
Pegu Power Project	18,90,70	2,45,00	3,20,00	3,80,00
Myingyan Steam Plant	9,23,90	1,23,00	1,22,00	1,74,00
Saingdin Falls Project	15,48,30	2,37,00	3,14,00	3,09,00
Kalewa Steam Plant	39,91	3,67	6,00	6,00
Paunglaung Power Project	15,59,00	—	—	—
Balu Chaung (Loikaw)	2,05,50	—	5,50	40,00
Lampha Chaung (Moulmein)	5,20,00	—	25,00	90,00
Mu River Power Project	6,70,00	—	—	
Magwe Transmission Line	1,94,00	—	—	
Prome Transmission Line	2,02,50	—	—	
Bassein Transmission Line	2,32,50	—	—	
Thaton-Tavoy Transmission Line	2,29,00	—	—	
Lashio Transmission Line	1,05,50	—	—	
Outlying Diesel Plants	1,21,00	—	—	
Total	96,34,94	8,45,67	11,92,50	14,55,13
IRRIGATION				
Mu River Storage Dam	4,34,11	35,00	1,05,13	1,81,62
Sinthe Chaung Dams Canal	4,09,54	66,93	1,14,95	1,26,43
Sinthe Chaung Pump System	1,53,76	53,73	21,18	23,46
Thitson Chaung System	2,24,21	9,77	64,24	85,64
Yamethin Well Irrigation	1,53,69	4,50	14,09	14,11
Kandaw Village Irrigation	75,45	27,97	47,48	
Loikaw Area Irrigation	74,01	6,62	14,02	14,85
Mu Diversion and Old Canal	4,31,38	—	78,39	98,64
Seikpyu Pumping Installation	21,92	—	21,92	
Irrawaddy Pumping Installation	1,83,39	—	—	32,49
Chindwin Pumping Installation	2,20,87	—	—	43,54
Westside Canal System	4,59,83	—	—	
Yezin Chaung Irrigation System	2,21,19	—	—	
Paunglaung Yezin System	93,51	—	—	
Ngalaik Chaung Irrigation System	3,66,64	—	—	
Paunglaung Pumping System	1,48,55	—	—	
Swa and Saing Irrigation System	8,42,82	—	—	
Total	45,14,87	2,04,52	4,81,40	6,20,78
PORTS AND WATERWAYS				
Port of Rangoon	27,11,40	1,89,60	3,83,40	4,04,20
Outports	1,98,50	73,75	71,75	23,00
Shipping Board	5,00,00	1,50,00	1,17,00	1,17,00
Inland Waterways	22,70,32	1,64,83	2,76,73	3,59,00
Total	56,80,22	5,78,18	8,48,88	9,03,20

*Estimated total cost, in some instances, includes costs beyond 1960.

XXV - 1

DEVELOPMENT PROGRAM

(Thousands of Kyats)

1956-57	*1957-58*	*1958-59*	*1959-60*	***Remarks***
1,00,00	—	—	—	
4,02,50	1,63,50	1,68,40	57,00	
1,71,40	71,40	74,10	74,10	Last unit to be in operation in 1959. Continuing work on transmission and distribution system after 1960
2,48,80	78,90	78,90	78,90	
3,56	3,56	3,56	3,56	
1,79,00	2,90,00	2,70,00	2,50,00	Project to be completed in 1963
40,00	20,00	20,00	20,00	Continuing work on Trans. and Dis. after 1960
90,00	90,00	45,00	45,00	,, ,, ,, ,, ,, ,, ,, ,,
70,00	1,00,00	1,00,00	1,00,00	,, ,, ,, ,, ,, ,, ,, ,,
34,00	40,00	40,00	20,00	,, ,, ,, ,, ,, ,, ,, ,,
42,50	50,00	50,00	15,00	,, ,, ,, ,, ,, ,, ,, ,,
22,50	40,00	40,00	40,00	,, ,, ,, ,, ,, ,, ,, ,,
—	19,00	60,00	60,00	,, ,, ,, ,, ,, ,, ,, ,,
—	—	25,50	30,00	,, ,, ,, ,, ,, ,, ,, ,,
11,00	25,00	25,00	25,00	Continuing work after 1960
14,15,26	9,91,36	10,00,46	8,18,56	
1,12,36	—	—	—	
1,01,23	—	—	—	
27,87	27,52	—	—	
64,56	—	—	—	
14,61	17,55	17,55	17,55	Project to be completed in 1963
—	—	—	—	
19,30	19,22	—	—	
1,12,25	1,42,10	—	—	
—	—	—	—	
37,70	39,70	36,75	36,75	
47,38	66,73	63,22	—	
57,30	70,45	1,85,15	1,46,93	
73,80	1,47,39	—	—	
—	39,51	54,00	—	
—	45,77	1,63,47	93,67	Project to be completed in 1961
—	—	32,62	34,51	,, ,, ,, ,, ,, 1963
—	—	—	1,73,39	,, ,, ,, ,, ,, 1963
6,68,35	6,15,94	5,52,76	5,02,80	
4,37,50	4,46,70	2,19,00	1,97,30	Improvements to continue after 1960
15,00	15,00	—	—	
1,16,00	—	—	—	
3,57,00	3,49,59	2,59,87	1,86,00	Improvements to continue after 1960
9,25,50	8,11,29	4,78,87	3,83,30	

continued

TABLE

SCHEDULE OF PROJECTS IN

(Costs in

	*Estimated Total Cost**	*1953–54*	*1954–55*	*1955–56*
RAILWAYS				
Civil Engineering Works	17,61,69	2,62,00	4,27,00	4,34,00
Mechanical Works	6,32,22	46,96	1,92,00	1,70,00
Equipment for Rail Laying, Ballast, etc.	41,00	—	11,00	30,00
Heavy Construction Equipment	30,00	—	30,00	—
Maintenance Equipment	19,00	—	11,00	8,00
General Office Changes	4,00	—	2,00	2,00
9 Diesel-electric Shunters	35,10	—	—	20,00
25 Diesel-electric Road Engines	2,07,50	—	—	—
Total	27,30,51	3,08,96	6,73,00	6,64,00
HIGHWAYS	81,95,00	3,32,00	7,10,00	8,78,00
AIRWAYS				
Improvement to Airports	4,89,64	1,19,64	1,25,00	1,25,00
New Aircraft	1,35,00	60,00	25,00	25,00
Additional Airport Improvements	1,25,00	30,00	25,00	25,00
Total	7,49,64	2,09,64	1,75,00	1,75,00
TELECOMMUNICATIONS				
Regulating Communications and Training	2,70	70	1,30	70
Central Telegraph Offices	1,86	1,86	—	
International Radio Telephone Line	5,00	5,00	—	
Delta UHF–VHF Circuits	16,50	8,00	8,50	
Rangoon–Mandalay Trunk	18,30	5,00	7,00	6,30
Radio Transmission and Receiving Centers	21,00	10,00	11,00	
Trunk Line Rehabilitation	20,00	2,00	5,00	5,00
District C–B Exchanges	71,50	7,50	8,00	8,00
Rangoon Auto Exchange	1,43,00	43,00	50,00	50,00
Total	2,99,86	83,06	90,80	70,00
MINERAL INDUSTRY				
Kalewa Coal Project	7,26,12	3,07,30	2,94,43	1,24,39
Myingyan Zinc Project	3,68,12	20,66	1,30,00	1,57,36
Lough Keng Exploration	1,65	56	1,09	
Lough Keng Development	51,42	7,00	21,00	23,42
Total	11,47,31	3,35,52	4,46,52	3,05,17

*Estimated total cost, in some instances, includes costs beyond 1960.

XXV – 1 *(contd)*

DEVELOPMENT PROGRAM

Thousands of Kyats)

1956–57	*1957–58*	*1958–59*	*1959–60*	*Remarks*
3,75,00	1,58,94	1,04,75	—	
1,20,00	90,00	13,26	—	
	—	—	—	
	—	—	—	
—	—	—	—	
	—	—	—	
15,10	—	—	—	
50,00	75,00	82,50	—	
5,60,10	3,23,94	2,00,51	—	
9,96,00	10,41,00	9,91,00	9,92,00	Program to continue after 1960
1,20,00	—	—	—	
25,00	—	—	—	
25,00	20,00	—	—	
1,70,00	20,00	—	—	
	—	—	—	
—	—	—	—	
	—	—	—	
	—	—	—	
	—	—	—	
	—	—	—	
5,00	3,00	—	—	
8,00	8,00	8,00	8,00	Program to continue after 1960
	—	—	—	
13,00	11,00	8,00	8,00	
	—	—	—	
60,00	—	—	—	
	—	—	—	
	—	—	—	
60,00	—	—	—	

[continued

TABLE

SCHEDULE OF PROJECTS IN

(Costs in

	*Estimated Total Cost**	*1953-54*	*1954-55*	*1955-56*
MANUFACTURING				
Bamboo Pulp and Paper Mill	5,92,00	1,68,41	1,80,00	1,23,59
Steel Products Plant	4,21,40	1,10,66	1,00,00	1,00,74
Jute Bag and Twine Mill	74,68	20,90	39,80	13,98
Rice Bran Oil Plant	35,22	5,22	25,00	5,00
Asbestos Cement Plant	21,24	11,00	10,24	—
Additional Cement Capacity	59,00	2,20	54,00	2,80
Sulphuric Acid Plant	1,51,50	—	—	11,50
Joinery Plant	27,69	27,69	—	—
Plywood Plant	27,62	15,00	12,62	—
Wallboard Plant	53,20	—	—	—
Saw Mill	48,30	—	2,00	35,00
Furniture Factory	14,18	—	8,09	6,09
Fertilizer Factory	7,00,00	—	—	72,80
Other Plants	73,47	—	—	—
Total	22,99,50	3,61,08	4,31,75	3,71,50
SUMMARY				
Power	96,34,94	8,45,67	11,92,50	14,55,13
Irrigation	45,14,87	2,04,52	4,81,40	6,20,78
Ports and Waterways	56,80,22	5,78,18	8,48,88	9,03,20
Railways	27,30,51	3,08,96	6,73,00	6,64,00
Highways	81,95,00	3,32,00	7,10,00	8,78,00
Airways	7,49,64	2,09,64	1,75,00	1,75,00
Telecommunications	2,99,86	83,06	90,80	70,00
Mineral Industry	11,47,31	3,35,52	4,46,52	3,05,27
Manufacturing	22,99,50	3,61,08	4,31,75	3,71,50
Total	3,52,51,85	32,58,63	50,49,85	54,42,88

*Estimated total cost, in some instances, includes costs beyond 1960.

XXV – 1 (*contd*)

DEVELOPMENT PROGRAM

(Thousands of Kyats)

1956–57	*1957–58*	*1958–59*	*1959–60*	***Remarks***
1,20,00	—	—	—	
1,10,00	—	—	—	
—	—	—	—	
—	—	—	—	
—	—	—	—	
—	—	—	—	
70,00	70,00	—	—	
—	—	—	—	
	—	—	—	
—	28,00	16,00	9,20	
11,30	—	—	—	
—	—	—	—	
2,87,70	2,75,00	64,50	—	
	47,00	26,47	—	
5,99,00	4,20,00	1,06.97	9,20	
14,15,26	9,91,36	10,00,46	8,18,56	
6,68,35	6,15,94	5,52,76	5,02,80	
9,25,50	8,11,29	4,78,87	3,83,30	
5,60,10	3,23,94	2,00,51	—	
9,96,00	10,41,00	9,91,00	9,92,00	
1,70,00	20,00	—	—	
13,00	11,00	8.00	8,00	
60,00	—	—	—	
5,99,00	4,20,00	1,06,97	9,20	
54,07,21	42,34,53	33,38.57	27,13,86	

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